SOIL SURVEY OF THE BITTERROOT VALLEY AREA, MONTANA.

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DESCRIPTION OF THE AREA.

The Bitterroot Valley area covers that part of western Montana known as the Bitterroot Valley, which includes the recent stream valley of the Bitterroot River, together with the adjacent older terraces and valley and foothill slopes. It comprises an area of 511 square miles, or 327,040 acres.

The larger part of the area is in Ravalli County and the remainder in Missoula County. The area is elongated, extending from Evelyn northward a distance of 61½ miles to a point 2½ miles north of Lolo, in Missoula County, where the river flows through a canyon.

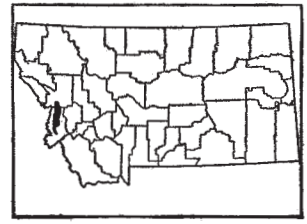


FIG. 63.—Sketch map showing location of the Bitterroot Valley area, Montana.

In width the area varies greatly, lying between the bold and rugged mountains on the west and the low, receding foothills of the main Rocky Mountain Continental Divide on the east. The foothills of the Coeur d'Alene Mountains touch the area north of Lolo Creek. South of Weeping Child Creek the average width is 3 miles. The main body of the area, lying between Weeping Child Creek on the south and Eightmile Creek on the north, varies from 6 to 14 miles in width, the maximum occurring just south of Stevensville. North of Eightmile Creek the width is but little over 3 miles.

The Bitterroot Valley area is almost entirely surrounded by forest reserves, which in many places, notably on the west side, it adjoins. The valley is a well-marked depression of structural origin. It is skirted by high and low terraces (Pl. LXXII, fig. 1), which are bordered on the west by the bold and rugged Bitterroot Mountain range and on the east by irregular foothills. That part of the valley lying west of the Bitterroot River is known locally as the West Side and the part lying east as the East Side.

The Bitterroot Range, which extends from the West Fork of the Bitterroot River almost due north to Lolo Pass, is geologically a structural, tilted block, rising from the valley with a remarkably uniform slope of 18 to 26°.[1] Throughout its extent it presents a series of serrated ridges, culminating in many high peaks. Trapper Peak, with an elevation of 10,175 feet, and El Capitan, with an elevation of 9,935 feet, both situated at the southern end of the range, are the highest peaks, and the average elevation of the highest summits is about 9,000 feet. The entire range, except the highest peaks, has been subjected to glaciation, and there are many deep canyons, which enter the valley at right angles. These are broadly U-shaped in the upper part of the valley, between Mill Creek and the West Fork of the Bitterroot River. (Pl. LXXII, fig. 2.) Glacial lakes and glacial cirques of polished granite are numerous throughout the range. Along the foot of the range from the West Fork of Bitterroot River to Lost Horse Creek heavy terminal and lateral moraines have been deposited at the dèbouchure of these canyons into the valley. (Pl. LXXIII, fig. 1.) These vary in height from 300 to 800 feet, the deepest deposit occurring on the south side of Lost Horse Creek. Similar areas or remnants of morainic material occur at the front of some of the more northern canyons, lying between Lost Horse and Fred Burr Creeks. The mountain slopes are moderately smooth, are covered by a fairly heavy growth of timber, and afford good pasturage for stock.

The foothills of the Rockies, which mark the eastern boundary of the area, present a striking contrast to the bold, imposing relief of the mountains on the west. These foothills extend from the head of the valley, just above the East and West Forks of Bitterroot River, in a northerly direction, roughly paralleling the Bitterroot Range. Spurs and ridges of the foothills, some of which have been included in the survey, extend toward and recede from the river, forming an irregular boundary. From the head of the valley to Weeping Child Creek they closely approach the river, the less pronounced slopes east of Darby giving way to a steep, rocky front over 1,000 feet in height, overhanging the river in the vicinity of Como (Pl. LXXII, fig. 1). North of Grantsdale the hills leave the river, but closely approach it again at Woodchuck Creek, in the northern part of the area. This marks the northern limits of the valley on the east side. Between Grantsdale and Woodchuck Creek the main body of agricultural land of the east side of the valley is situated. The eroded and dissected foothills, sparsely covered with pine and fir, rise gradually from the valley floor toward the east for many miles, in places attain-

[1] U. S. Geol. Surv. Prof. Paper 27, p. 39.

ing elevations of 6,000 to 8,000 feet. Shore lines, terraces, and delta deposits are present in many places in the eastern part of the valley, giving evidence of the existence of former lakes, and inextensive remnants of this material occur on the opposite side of the valley. Lacustrine sediments have been deposited on the lower slopes of the foothills and material of somewhat similar character seems to occur in the vicinity of Lolo on the West Side. While in many places much erosion has taken place on the foothills of the East Side, they still, as a whole, possess smooth slopes, which afford good pasturage and support a fair growth of timber.

Elevations in different parts of the valley vary much. Darby, at the upper or southern extremity, is 3,882 feet above sea level, while Lolo, at the lower end, is 3,187 feet above. In places along the eastern foothills the area surveyed attains an elevation of 5,000 feet. The elevation of the larger part of the valley, however, is less than 4,000 feet.

The East and West Forks of the Bitterroot River unite at a point 5 miles above Darby, in the southern part of the area, whence the river follows a northerly course, with an average grade of more than 10 feet per mile, to its junction with Clark Fork, 65 miles distant. The normal overflow plain of the river is skirted by low terraces, especially in that part of its course between the southern extremity of the area and Woodside (Pl. LXXII, fig. 2). North of Woodside this flood plain widens, often being subjected to overflows from sloughs branching from the river, and the terraces are poorly defined or the flood plain merges with alluvial-fan deposits of tributary streams.

Many important tributaries enter the main stream from the west. These have their sources in the glacial lakes in the Bitterroot Range and enter the valley through steep, rocky canyons. Their courses are generally straight and they have few tributaries. In many places they have a grade of 300 to 400 feet per mile. The valleys of these tributary streams contain no agricultural land, and the slopes traversed by them are frequently so stony as to render cultivation difficult. These perennial streams are of much importance to the valley as a whole, as they furnish a splendid supply of water for stock and for irrigation. The principal creeks entering the valley from the west are Tin Cup, Bunkhouse, Rock, Lick, Lost Horse, Blodgett, Mill, Sweathouse, Big, Bass, and Lolo.

A number of tributaries also enter the river from the east. These have carved valleys, more important agriculturally, which gradually increase in width as they approach the main valley. The general direction of these streams is slightly north of west and the fall is much less than in the streams entering from the west. The former

carry but little water, many of them being dry the greater part of the year. The principal streams are Weeping Child, Skalkaho, and Willow Creeks, Burnt Fork, and Threemile and Eightmile Creeks. Important terraces occur along Burnt Fork and Willow and Skalkaho Creeks.

The Bitterroot Valley was the route selected by Lewis and Clark in making their famous expedition to the Northwest in 1805, and they were the first white men to enter the area, which was inhabited by the Selish or Flathead Indians. The first white settlement was made in the fall of 1841, when St. Marys Mission, near the present site of Stevensville, was established. Owing to continual attacks by hostile Indians, St. Marys Mission was abandoned a few years later and remained unoccupied until 1850, when it was sold to Maj. John Owen and became the nucleus of the first permanent settlement. Attacks by Indians continued with more or less frequency until 1855, when Gov. Stevens negotiated a treaty with the Flathead, Blackfeet, and Crow Indians. Settlement of the valley progressed very slowly, however, owing to the greater attraction of the gold fields.

The 1910 census reports the population of Ravalli County as 11,666. The density of the rural population is less than 5 per square mile. As much of the country is, however, mountainous and only sparsely settled, the agricultural part of the Bitterroot Valley has a density much greater than the average for the county.

According to the census, about 62 per cent of the population of the area is of native birth. The foreign-born population consists mainly of Canadians, Bulgarians, Germans, and English, the Canadians predominating. Many settlers have come into the valley from other Northern States to engage in fruit culture.

Hamilton, the county seat of Ravalli County and the principal town of the area, has a population of 2,240. It is situated on the east side of the river and is the industrial center in Ravalli County. Among the industries located in or near the town are large sawmills, a box factory, a grist mill, fruit-packing houses, and a creamery. These furnish employment to many persons. The town is well supplied with churches and schools.

Stevensville, population 796, the oldest town in the valley and the second in importance, is also situated east of the river, 20 miles below Hamilton and 2 miles from the railroad. A cooperative creamery is located there.

Corvallis, also situated on the east side of the river, and about 2 miles from the railroad, is the center of the grain-growing district of the valley. A branch of the Montana Agricultural Experiment Station is located northeast of Corvallis. A cheese factory is the important industrial interest in this town.

Grantsdale, the only other town east of the river, is situated 3 miles south of Hamilton.

West of the river, Darby near the head of the valley, Woodside and Victor in the central part, and Florence and Lolo in the northern part, are settlements of local importance. All these towns are in Ravalli County, with the exception of Lolo. Besides these towns there are a number of stations or sidings which are more or less important shipping points.

All parts of the area are within easy reach of a branch of the Northern Pacific Railroad, which traverses the central part of the valley from Missoula, 10 miles north of the area, to Darby, in the extreme southern part. There are good wagon roads throughout the valley.

The old public-school system is being rapidly superseded by the consolidated system, under which the pupils within certain sections are conveyed to central schoolhouses located in the towns.

Butte, with a population of 39,165, and Missoula, with 12,869, are important markets within the State for the products of the valley, especially those of a perishable nature. While there is a good local demand for farm products, the greater part must find a market outside the State. The production of fruits has assumed such proportions that cooperative organizations have been formed to handle and market them. Many of the crops that bear shipment well, such as grain, potatoes, apples, and small fruits, as well as live stock, find markets in the East.

General health conditions in the area are very good, although serious trouble has been experienced in certain sections of the valley from the Rocky Mountain spotted fever.[1] The mountain streams furnish an abundance of pure water for all the towns and villages of the area.

CLIMATE.

The climate of the Bitterroot Valley is characterized by cool, pleasant summers and comparatively mild winters. In the spring and fall the days are warm and pleasant, while the nights are cool and often frosty. Although little rain falls in summer, thunderstorms are not uncommon, being most frequent and severe near the mountains. Irrigation is necessary for the successful production of crops, except dry-farmed grain.

In an area of such varied topography the data obtained at one or two points can only serve to indicate the general climatic conditions.

[1] See Bul. 105, U. S. Dept. of Agr., on the Rocky Mountain spotted-fever tick.

Hamilton, where is located the local station of the Weather Bureau at which the data used in this report were compiled, lies out in the valley and, therefore, allowance must be made for variations in parts of the area lying on and in the vicinity of the mountain foot slopes and terraces, and in sections subject to the influence of air currents from the canyons. This influence is marked in the vicinity of the larger canyons, especially at Lolo, where fruit can be grown with less danger of damage by frosts, even on the valley floor, than in other sections. The precipitation in those parts of the area lying adjacent to and on the mountain foot slopes of the West Side is greater than in the same relative positions on the East Side. On the valley floor it is less than on the eastern foothills.

The mean annual temperature at Hamilton is 45.8°, while at Missoula, located in the center of the Clark Fork Valley, to which it bears the same relation that Hamilton bears to the Bitterroot Valley, the mean annual temperature is 43.8°. At Hamilton the mean annual precipitation is 10.71 inches, while at Missoula it is 15.84 inches. The average yearly snowfall at Missoula is but 24 inches, as compared with 37.8 inches at Hamilton. The snow sometimes remains upon the ground for only brief intervals, particularly in the periods of chinook winds. Owing to the absence of snow cover, field crops and trees are sometimes damaged by freezing. Fruit buds may be forced to early development by the warm winds and damaged by frost later in the spring. Good air drainage is necessary to successful orcharding, and injury from frost is much less frequent or severe on the terraces and slopes and in the vicinity of canyons than on the lower lying valley lands, where, on still nights, there is little air movement.

The average date of the first killing frost in the fall at Hamilton is September 24, and of the last in the spring May 12, giving an average growing season of 135 days. The earliest recorded date of a killing frost in autumn is September 14, and the latest in spring May 25.

The prevailing wind direction in the valley, as recorded at Hamilton, is west. Winds of sufficient velocity to damage fruits or other crops rarely occur.

The climatic conditions of the Bitterroot Valley are favorable for the growth of hardy, late blooming fruits. Crops requiring a long growing season can not be successfully grown.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station at Hamilton:

Normal monthly, seasonal, and annual temperature and precipitation at Hamilton.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	28.0	57	−10	0.58	0.50	0.33	4.4
January	26.3	57	−33	0.95	0.70	3.69	13.3
February	30.9	65	−28	0.56	1.61	0.41	6.5
Winter	28.4	65	−33	2.09	2.81	4.43	24.2
March	36.6	70	−13	0.72	0.57	1.01	8.2
April	46.8	83	15	0.86	0.09	1.50	1.4
May	52.6	90	18	1.68	0.14	0.84	0.1
Spring	45.3	90	−13	3.26	0.80	3.35	9.7
June	58.2	93	30	1.71	0.04	1.85	T.
July	65.5	96	38	0.65	0.02	2.45	0.0
August	65.3	94	36	0.64	0.12	0.17	0.0
Summer	63.0	96	30	3.00	0.18	4.47	0.0
September	57.0	89	28	0.94	0.08	1.99	T.
October	45.7	79	11	0.77	1.25	0.48	T.
November	36.6	70	− 9	0.65	0.14	1.86	3.9
Fall	46.4	89	− 9	2.36	1.47	4.33	3.9
Year	45.8	96	−33	10.71	5.26	16.58	37.8

AGRICULTURE.

Farming was begun in the Bitterroot Valley area in the spring of 1842 at St. Marys Mission. The first crops grown were wheat and potatoes. Cattle were also introduced about the same time. A little later sawmills and grist mills were erected at the mission. Prior to 1855 little progress was made in agriculture, the settlers being continually harassed by Indians. About 1850 many cattle were brought into the valley by traders, who were attracted to the region by the large number of immigrants that traveled the highway to California and the Northwest. After the signing of the treaty with the Indians in 1855 agriculture and stock raising received a new impetus.

The rapid increase in the population of the valley following the discovery of the Kootenai Mines in 1864 caused a shortage in the food supplies and an increase in the war prices already prevailing, as a result of which grain farming and potato growing became very

important industries. These crops were first grown on the valley lands, where water could be obtained for irrigation.

Lumbering became important about 1885, with the completion of the railroad.

The most important crops grown at the present time are orchard fruits, small fruits, grains, potatoes, hay, and field peas for seed. Stock raising is one of the foremost industries in the valley. The soil and climatic conditions are well suited to dairying, and this industry is expanding.

The development of fruit growing was begun about 10 years ago, when western fruit first began to attract attention. At the present time thousands of acres are set out in orchards, consisting mainly of apples, pears, and cherries. Most of these are just coming into bearing. The setting of orchards has not been confined to any particular section of the valley. As a rule the sites have been selected chiefly because of their position above the valley floor, the higher benches and foothill slopes on both sides of the valley being largely used. The entire valley of Threemile Creek, a large part of that of Eightmile Creek, the somewhat lower lying soils of the Victor series on the West Side, and parts of the main valley are also used. In the higher parts of these valleys there is little more likelihood of injury from frosts than on the higher benches and foothill slopes, but in the lower parts there is considerable danger.

Failures in fruit growing have been due to the lack of care in the selection of suitable soils and orchard sites. Soils ranging in texture from a leachy gravelly sand to the heaviest clay loam have been used. Orchards have been set out on some of the lighter types of soils, with a rolling to steep topography, without due consideration of the increased difficulties of irrigation and cultivation and the damage likely to result from erosion. On hillsides having a southern or western exposure much loss results from winterkilling of the trees. The light-textured soils, which predominate in such positions, hold but little moisture. They warm up readily on warm, sunshiny days and cool off quickly on cold nights, thus subjecting the trees to extremes which they can not endure.

Although the ideal soil for apples is a well-drained one in which the surface soil approaches a loam and the subsoil ranges from a loam to a clay loam, good results have been obtained, where the topography is not too steep, on moderately heavy sandy loams. The heavier types of soil are usually underlain by compact, dense subsoils or a hardpan, and the success of orchards upon this character of land depends upon the effectual breaking up of this layer when it lies at a depth not sufficient to allow the growth of deep-rooted plants.

While most of the soils selected for orchards have been fairly well drained, some orchards have been set out upon areas so poorly drained as to make them unfit for this purpose. Soils on good slopes, but lying under the larger ditches, are often subjected to seepage, especially where the subsoils are very heavy and impervious. The same injury occurs in places having a high water table fed by seepage from the tributary streams entering the valley.

Cherries can be successfully grown upon lighter soils than is necessary for apples. Pears, of which there are only a few plantings in the valley, do well upon types of soils heavier than those suited to apples. They often succeed on soils whose drainage is too poor for the latter fruit.

Late blooming and late maturing fruits do best in this region. Among the varieties of apples successfully grown the McIntosh, Jonathan, Wealthy, Gano, Black Ben, and Delicious are most popular. The leading varieties of crab apples are the Transcendent, Martha, Florence, and Hyslop. Fair yields are obtained, and the fruit is of good color, quality, and size.

The time required for apple trees to come into bearing in this valley is seven or eight years, and for crab apples five or six years.

In apple orchards blight, scab, and scale are sometimes troublesome. Dormant cutting is resorted to for blight, while the lime-sulphur spray is effective in the control of scab and scale. The codling moth, so troublesome to apple growers in other parts of the country, has so far not been active in the area.

The Bing, Lambert, Napoleon (Royal Ann), May Duke, and Republican are the principal varieties of cherries grown. Among the sour varieties the English Morello, Montmorency, and Richmond seem to be best suited to the prevailing conditions. Sweet varieties come into bearing in about seven or eight years, while the sour varieties often produce fair crops in three or four years, for which reason they are frequently used as fillers in orchards of the sweet varieties. The fruit is of excellent quality, size, and color, and there is a good demand for it. The sweet cherries are not so hardy as the sour varieties, and care is necessary to prevent winterkilling. Both types are affected by gummosis and attacked by the black aphis. The latter is kept in check by the use of the nicotine spray.

The growing of pears in the valley has been seriously curtailed by blight. If this were kept in check, the pear industry should be profitable, as there is always a good demand for the fruit. The varieties grown in this area are Bartlett, Flemish (Flemish Beauty), d'Anjou, Winter Nelis, Comice, Lawrence, and Kieffer. Orchards begin to bear in five or six years, and fair yields are obtained.

Small fruits, such as strawberries, raspberries, and currants, are grown, but not extensively enough to supply the home demand. Va-

rieties of strawberries giving good results in the area are the Dunlap, Glen Mary, and Warfield. These succeed best on a heavy, well-drained sandy loam, loam or clay loam. They can be grown on shallower soils than the tree fruits. Where planted on slopes with a southern exposure quick growth and fruiting result after the winter mulch has been removed. The fruit matures later in the season than in many of the neighboring valleys, and as it stands shipment well, readily finds a good market in other parts of the State and country. Raspberries, both black and red, give good yields. Neither strawberries nor raspberries are affected to any extent by disease.

It has been the practice of orchardists in this area to grow crops between the rows of young trees. Field peas are most commonly used for this purpose, the crop being harvested and sold for seed. In many cases not enough water has been supplied to insure the growth of both crops, and in such cases the trees, especially on the lighter types of soil, have not made a normal growth.

Smudging to prevent injury from frost has not been practiced to any extent in the area. Apples and pears, blooming comparatively late, are not usually injured by frost, but the yield of cherries and of the small fruits that bloom earlier, is often materially reduced by late spring frosts.

Cover crops have not been extensively grown in the orchards in this valley, the custom being to give them clean cultivation throughout the season. As a result many of the slopes of lighter textured soils have suffered from erosion and much winterkilling has resulted. Some protection to the surface is afforded where crops are grown between the rows.

There are no facilities for the storage of fruit in the area, and it must therefore be placed on the market early in the season. At present the unmarketable fruit is not utilized, except to a small extent as feed for stock. There is opportunity for the development of factories for drying, canning, and preserving fruits and for manufacturing cider, vinegar, and other products from the waste of the orchards.

Truck growing has not been extensively developed in the Bitterroot Valley, and at present the supply does not meet the local demand. Such crops as beans, corn, tomatoes, and melons, owing to their greater liability to injury by frost, require more care than the hardy vegetables, such as celery, onions, and cabbage, and are therefore less profitable. Many of the heavier, dark soils of the valleys, suited in their present condition only to pasture, could be profitably used for the hardy truck crops if properly drained.

Potato culture receives considerable attention in the valley. The 1910 census reports 386,998 bushels grown on 2,327 acres in Ravalli County. This is at the rate of about 165 bushels per acre. A large

part of the crop is produced on the brown, friable fine sandy loams and loams of the lower terraces. A part of the crop is grown on the West Side, but the industry is confined largely to areas east of the river, mainly around Hamilton and Grantsdale. Considering the fact that in these soils the water table frequently rises to within 2 or 3 feet of the surface, the crop does very well.

Grain farming has been important in the valley from the first. Fair yields of grain are always assured where irrigation is practiced, and in those parts of the area lying above irrigation fair yields are obtained, by allowing the land to lie fallow in alternate years. The production of wheat in Ravalli County in 1909 amounted to 180,304 bushels from 6,558 acres, an average of over 27 bushels per acre. There were 14,317 acres devoted to oats, from which the production was 811,219 bushels, or about 57 bushels per acre. The oats are heavy and of good quality. The wheat grown under irrigation is soft and has poor milling qualities. Grains are grown chiefly on the heavier soils of the valley floor, on the better drained and moderately heavy types of the river flood plain, and on many of the higher bench and foothill soils. In the latter situations the land is in fallow every other year. The largest yields are obtained on the heavy soils of the valley floor, oats averaging about 75 and wheat 50 bushels per acre. On the foothill slopes east of the river the wheat yield ranges from 25 to 40 bushels per acre without irrigation, but the land is idle during alternate years for fallowing. On the better drained portions of the heavy fine sandy loams and loams along the river bottoms, where subject to only occasional overflows, good yields of both wheat and oats are obtained.

Only comparatively small quantities of barley and rye are produced in the valley. These grains are grown on the same kinds of soils as wheat and oats and under similar conditions. Their production could be profitably extended.

Alfalfa is more extensively grown than any other legume. The 1910 census reports the area devoted to it as 1,774 acres, with a production of 4,090 tons of hay. While the ordinary yield per acre is less than 2½ tons, the fields also furnish pasturage for stock during a part of the year. No attention has been paid to the production of alfalfa seed.

Alfalfa is grown principally on the soils of the valley floor, on the bench lands of the east side, and on the alluvial fans on the west side of the valley. Many areas that lie too low for the best development of fruit trees, owing to the occurrence of frosts, are well suited to the production of alfalfa. Alfalfa requires a well-drained soil, and many of the gravelly, stony, and other soils of porous structure are well suited to it. In this region alfalfa takes the place of corn

as a feed for dairy cattle, the latter crop not being suited to the climate.

Clover is grown mainly on the calcareous bench lands, and only a small acreage is devoted to it. The average yield is less than 2½ tons per acre. While clover makes a very good hay for dairy cows and other stock, it is not so good as alfalfa. Clover and timothy mixed are more extensively grown than clover alone. They are frequently grown upon wet areas. The average yield is less than 2 tons of hay per acre. Timothy alone is grown mainly on the poorer drained soils of the valley floor. The ordinary yield is somewhat less than 2 tons per acre.

The growing of Canada field peas for the seed has attracted considerable attention in the area. This crop is grown chiefly on the bench lands and the valley floor of the East Side. It is planted between the rows in many orchards throughout the valley, but this practice is not considered good. Peas are well adapted to the climatic conditions of the valley, and furnish a good feed for cattle and hogs. They are also valuable as a winter cover crop. The ordinary yield is about 20 bushels per acre. The crop is grown under irrigation.

Sugar beets are grown to a small extent and good yields are obtained, but there is no market for the crop and it is fed to stock.

The lumbering industry has assumed some importance since the early eighties, when the railroad was built. There are thick forests of pine and fir on the lower mountain slopes, while tamarack and lodgepole pine grow at higher elevations. The latter are of little value. Many farm laborers are employed in the lumber camps during the winter and spring months.

Stock raising has been carried on profitably and extensively in the Bitterroot Valley since the days of the pioneers. The well-watered mountain slopes and valleys furnish good pasturage during the greater part of the year. The comparatively mild weather makes it possible to raise stock on the range without supplying feed in winter, although this practice is not advisable, and is not carried on with the better grades of stock, which are fast replacing the range stock.

Horses, cattle, sheep, and hogs rank in importance in the order named. Laws regulating the breeding and prohibiting the use of grade stock for breeding purposes have been responsible for the importation of much registered stock. While more draft horses are raised in the valley than any other kind, the lighter breeds have not been overlooked. The valley was once famous for its race horses.

At present the cattle consist mainly of beef breeds, although the raising of dairy cattle is receiving much attention. There is much fine stock, both of the beef and dairy breeds.

Sheep are grazed largely in the hills and mountains, where, during the open season, conditions are very favorable to the industry. The medium wool breeds are largely represented. Few goats are raised.

Hog raising is a profitable industry in the area. It is confined mainly to the soils of the valley floor. There are many good pens of Poland China, Berkshire, and Duroc Jersey breeds. The Tamworth is also being introduced. Much unmarketable fruit that now goes to waste and the by-products of the dairies might well be fed to hogs.

Poultry raising and beekeeping are also profitable, and the local demand for poultry, eggs, and honey is greater than the supply.

The value of domestic animals, poultry, and bees in Ravalli County in 1910 was $1,313,246. The value of the horses exceeded that of all other stock combined, being $742,078.

The 1910 census reports 1,055 farms in Ravalli County, but the number has since been increased by the subdivision of some of the larger holdings. About 6 per cent of the farms in this county are conducted by managers, over 12 per cent by tenants, and about 82 per cent by owners.

Farm equipment is generally of the latest and most improved type. The average value of implements and machinery per farm in Ravalli County in 1910 was $375. Many fruit farms are well equipped for the handling and packing of fruit; the products of others are packed by the selling organizations. All the fruit grown in the valley stands shipment well.

Practically no attention is paid to the rotation of crops, and very little commercial fertilizer or barnyard manure is used. Legumes are grown to some extent as winter cover crops and green manures.

According to the 1910 census, $534,958 was expended for labor in Ravalli County on the 640 farms reporting, making the average per farm somewhat over $800. Ordinary farm laborers receive $1.50 to $2.50 a day, without board. Experienced fruit pickers and packers earn from $3 to $6 a day. The usual charge for irrigating, cultivating, and hoeing orchards throughout the growing season by contract is $20 an acre.

In 1910 the average size of farms in Ravalli County was 198.8 acres, the average number of improved acres per farm being 101.1 acres. These averages have decreased since then owing to the subdivision of the larger farms. The average value of farm land in 1910 was $73.50 an acre, as compared with $16.26 in 1900, the increase being due to the development of the land for orchards. At the time of the survey the price of unimproved land ranged from $15 to $250 an acre, depending on character of soil, location, topography, and water rights. The usual price of irrigated orchard land containing 5-year-old trees is $500 an acre. Where the trees are older the price within certain limits is correspondingly higher.

SOILS.

The Bitterroot Valley area is a region of varied soils and topography, having been subjected to considerable modification by stream, glacial, and lacustrine agencies. Of these, stream action seems to have been the most important. Glaciation, so far as it has affected the soils of the area, is restricted to the mountains on the west side of the valley. It would appear, however, that detritus from the glacial deposits accumulated in lakes which were formed in the valley. After the subsidence of these lakes the valleys were subjected to accumulation of stream deposits and to erosion and terraces of various elevations were left. The entire valley is believed formerly to have been filled with gravel to a height of several hundred feet above its present level. The East Side foothills and the Bitterroot Mountains on the west are formed mainly of granite and gneiss, which are the principal materials entering into the formation of the soils through most of the survey. In places rhyolite intrusions occur, and sedimentary and metamorphic rocks, which are old geologically and are known as the Lolo series, occur in the extreme northern part of the area.[1] Similar rocks also occur in various places on the east side of the valley and about the headwaters of the Bitterroot River. Veins of quartz are occasionally seen in different parts of the area. Volcanic ash occurs at various places in the formations as pockets, usually of small extent. In the main valley and the valleys of its tributaries from the east material derived from quartzites and schists is also well represented. In the tributary valleys from the west, which are very narrow, granite and gneiss are the chief source of soil-forming material, except in the Lolo Valley, where sedimentary and metamorphic rocks are important.

For purposes of classification the soils of the Bitterroot Valley area are divided according to their origin, mode of formation, and topographic position into six groups: (1) Residual soils; (2) soils derived from glacial material, (*a*) ice laid, (*b*) water laid; (3) soils derived from old valley filling; (4) soils derived from recent alluvial-fan material; (5) soils derived from the recent alluvial deposits; and (6) miscellaneous material. Fifteen soil series, embracing 36 soil types, and 2 miscellaneous soils, are recognized in the area.

The residual soils are those derived from the breaking down or weathering in place of consolidated rocks. In this survey the residual soils are of small extent and of little agricultural importance. They are derived mainly from granite and gneiss, have a predominantly rolling to hilly topography, and occur mainly above the level

[1] U. S. Geol. Sur. Prof. Paper No. 27, p. 34.

of irrigation. They are grouped in the Moscow series, in which three types are shown.

The soils derived from glacial materials cover practically all the area on the west side of the present valley of the Bitterroot River from the West Fork on the south to Carlton Creek on the north, except the stream bottoms and recent alluvial fans. The soil material comes almost wholly from granite and gneiss. The ice-laid deposits consist of terminal and lateral moraines, the topography of which is that of steep hills, often several hundred feet in height. These accumulations were deposited by tongues of ice which extended down the narrow canyons from the fields of ice covering the higher elevations of the Bitterroot Range. Although glaciation probably extended throughout the entire range, the lower parts of the canyons north of Mill Creek show little or no evidence of it, and no recognized ice-laid deposits occur at their mouths. All the canyons of any importance from Mill Creek south to the West Fork of the Bitterroot River have been glaciated and are broadly U-shaped (Pl. LXXII, fig. 2), while lateral and terminal moraines, trenched by streams, lie at the mouths of these canyons. The deposits occurring at the mouths of the Lost Horse, Lick, Rock, and Tin Cup Canyons are extensive (Pl. LXXIII, fig. 2). The moraines lying at the mouths of the Sawtooth, Roaring Lion, Blodgett, and Mill Creek Canyons are of small extent and are rough in topography and stony, which renders the soils of little agricultural value (Pl. LXXIII, fig. 1). The soils derived from ice-laid material are represented in this area by the Lick series.

The soils derived from outwash fans deposited by the torrents caused by melting ice are of much greater extent and agricultural importance than those from ice-laid material. The former cover most of the area on the west side of the valley. These deposits are broad sheets of material or alluvial fans of steep to gentle slope and extend from the foot of the mountains to the valley floor or to the river. (Pl. LXXIII, fig. 2.) The lower sloping, terraced margins of the fans are frequently terminated by steep, indented, and eroded escarpments a hundred feet or less above the valley floor (Pl. LXXIV, fig. 1). The material appears to be of stream-laid character, but was deposited by swiftly flowing streams of steep gradient, and much of it is incompletely assorted and imperfectly stratified. Large glacial bowlders, probably deposited by floating ice, frequently occur in the vicinity of the ice-laid morainic deposits. The line of demarcation in the vicinity of the foot of the mountains between the soils of this group and those of ice-laid origin is at times somewhat indefinite, and as mapped these soils may include locally some undifferentiated ice-laid material. On the other hand, the lower margin of the fans may locally

merge with the more recent alluvial fans of post-glacial deposition. Unlike the recent alluvial fans, however, the older fan deposits which, where typically developed, lie immediately below and in contact with the morainic deposits, are not being added to at present, but are undergoing the process of removal by erosion. Apparently they were formerly much more extensive than at present and may have constituted a continuous plain of glacial-stream distributed material along the western side of the valley. They are deeply entrenched by the present perennial streams entering the valley from the mountain canyons and their continuity is interrupted by areas of alluvial-fan deposits of recent age. Some of the higher lying areas in the vicinity of the mountain foot slopes have been eroded sufficiently to create an undulating or rolling topography.

From Charlos to the southern extremity of the valley these outwash deposits have largely covered and obscured granitic formations, carrying intrusions of rhyolite, outcrops of which are seen where the outwash fans join the valley floor or approach the river. Rounded quartzites, cobbles, and bowlders occur frequently on the eastern border of the indented terraces. These were probably deposited by the Bitterroot River, being derived from the sedimentary rocks at the head of it. Angular to subangular and rounded rocks of quartz and quartzite are also common upon the soils of this group from Victor to Carlton Creek. Sedimentary formations outcrop on the mountain side in this vicinity, and these are very likely responsible for the rocks occurring at this place. Angular to subangular bowlders and fragments of pegmatites and schists are conspicuous in the vicinity of Carlton Creek along the line of contact with the sedimentary and metamorphosed sedimentary rocks. These rocks have influenced the soil but little, as they weather very slowly and do not occur in sufficient numbers. Several small outcrops of rhyolite occur in areas of the outwash material near the hills southwest of Florence. In certain parts of the valley the older glacial stream-formed fans and terraces resemble in topography, and to a less extent in character of material, the older valley-filling deposits of probable lake-laid origin which are extensively developed along its eastern side, and as mapped the soils may include some areas that should really be included with this latter soil group. A gravel and bowlder substratum, often showing only partial stratification, underlies the soils, except in small areas of shallow deposits resting on granite and rhyolite or sedimentary rocks.

The separation of the soil series occurring under this group is made chiefly on the basis of the color of the soil, as the material giving rise to the soils is practically the same. These consist of the Bass and the Como series of soils, which sometimes occur on the same terrace at different levels. The Bass series is the more important of

the two. It is distributed over a large part of the west side of the valley, from University Heights to Carlton Creek.

The glacial outwash soils are important in the agriculture of the valley. They are high above the valley floor, and frosts are less frequently injurious than upon the lower lying lands. Water for irrigation is available from the many perennial streams that traverse this part of the valley. The slope of the surface is toward the east—a desirable exposure for fruit culture.

The soils derived from old sedimentary valley-filling deposits are in general topography not greatly unlike some of the glacial outwash fans of the west side of the valley. They are, however, frequently eroded to a greater extent. They have generally weathered in place sufficiently to develop heavy subsoils or hardpans. They are derived very largely from granites, although fragments of quartzite and other sedimentary and metamorphosed sedimentary rocks are present, especially from a point east of Victor to the lower end of the valley.

The country occupied by these soils is that of high terraces and old eroded alluvial fans and valley slopes. While the terraces and slopes are generally smooth and gently sloping, erosion has been more active where the terraces give way to the valley, and in places the topography becomes steep and rolling, and deep gulches often dissect the surface. Remnants of earlier lake-shore lines are frequently observed. Deep sedimentary deposits underlying the soils of this group extend high up on the foothills.

The material giving rise to the soils of this group contains calcareous material, and the cementing of the gravel by lime has produced the hardpan or soft conglomerate already referred to. The substratum is usually of light-reddish or light-yellowish to gray color and of fine texture, and presents an adobelike structure upon exposure to the air. Pockets of volcanic ash are of frequent occurrence in this material. A finer textured, harder conglomerate material than the usual cemented layer outcrops along Birch Creek. Over much of the area mapped the valley-filling materials are apparently of lake-laid origin. The coarser material, however, consists, at least in part, of later alluvial-wash or alluvial-fan deposits, and some of the coarser strata occurring in the lake-laid silts and clays may be stream laid.

The soils of this group occupy the terraces and slopes of the eastern side of the valley and cover most of the land of value of the East Side, except that of the stream valleys. They extend from a point 1 mile south of Weeping Child Creek to Eightmile Creek, east of Florence. A small body of apparently similar material seems to have been cut off from the parent body by the Bitterroot River at Victor and lies on the west side of the valley. Many of the soils of

the group are stony. The texture of the terraces, however, becomes much lighter as they advance toward the valley.

The soils derived from old valley filling are agriculturally important. Owing to their position and perfect air drainage they have been planted extensively to fruit. Areas lying below an elevation of about 3,700 feet are irrigated by a large canal leading from one of the glacial lakes on the West Side. Above this elevation irrigation is not practiced, except locally. This group of soils is represented by the Bridger, Burnt Fork, and Ravalli series.

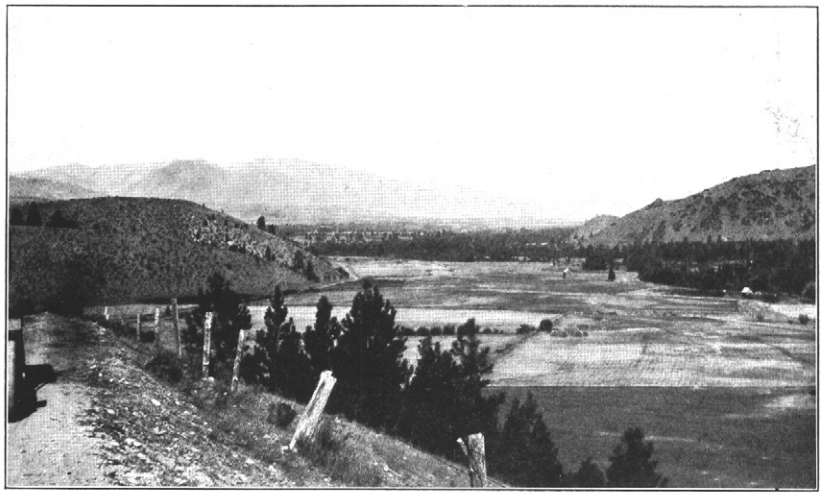
The soils derived from alluvial-fan material are typically developed along the west side of the valley, mainly between Tin Cup Creek on the south and Carlton Creek on the north. The surface generally has a uniform slope and is not eroded (Pl. LXXIV, fig. 2), and, unlike the adjacent higher lying, eroded fans of the glacial-outwash deposits, they are still in the process of building. Besides the typical fan areas, certain colluvial foot-slope areas and some narrow bottom-land areas lying along deeply intrenched streams have been mapped with this group.

The alluvial-fan soils are included in the Victor and the Garrison series, which are differentiated upon the basis of origin and character of material. Of these the Victor is the more extensive and important. The Garrison soils are similar to the soils mapped under this name in Stevens County, Wash., though the latter were formed of more elevated glacial-outwash terrace material. In the present survey the series is not extensive.

The recent alluvial soils occupy the present flood plains and terraces of the streams traversing more or less well defined valleys. They are most typically developed in the present valley of the Bitterroot River, but large areas also extend up the valleys of some of the principal tributary streams.

The overflow plains are usually narrow and are bordered by gravelly terraces not subject to overflow. In places, however, the bottoms, including the lower terraces, are broad and in this case sometimes poorly drained. The higher stream terraces may be underlain by earlier lake-laid material, and they often merge imperceptibly into areas of old valley filling material. The line of distinction between the true river-built terraces and the material of the adjacent valley slopes deposited as alluvial fans or as glacial-outwash deposits is also frequently indefinite.

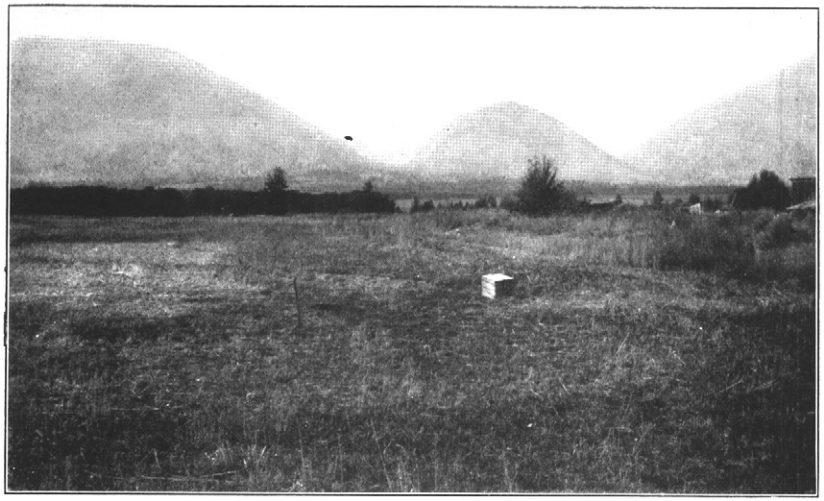
The alluvial soils are most extensive on the east side of the valley. They vary much in texture, ranging from light, gravelly types to heavy clay loams. The lighter types are almost universally gravelly or stony. A narrow strip of soil, paralleling the river and lying just below the high East Side benches, is heavy in texture and practically free from stones or gravel, except in the deeper sub-



S7940

FIG. 1.—LOOKING DOWN BITTERROOT VALLEY FROM UPPER PORTION ABOVE DARBY.

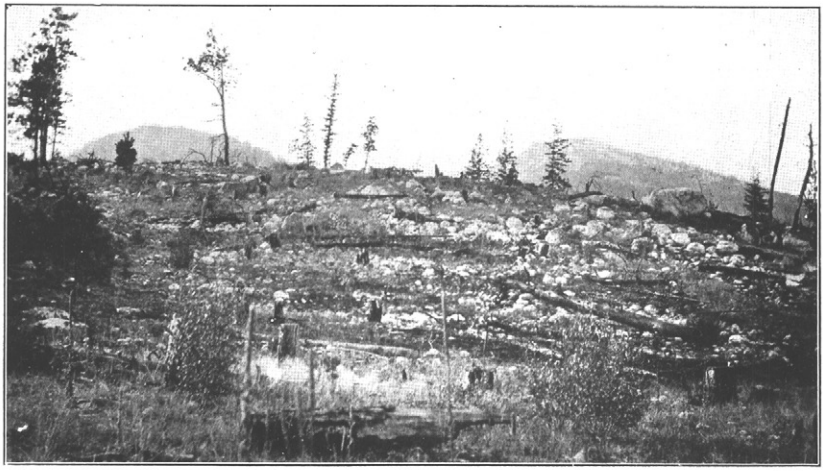
Lower valley terraces occupied by soils of Grantsdale and Waterloo series. High terrace of Bass series on left. Rough stony land on right forming eastern margin of valley near Como.



S7942

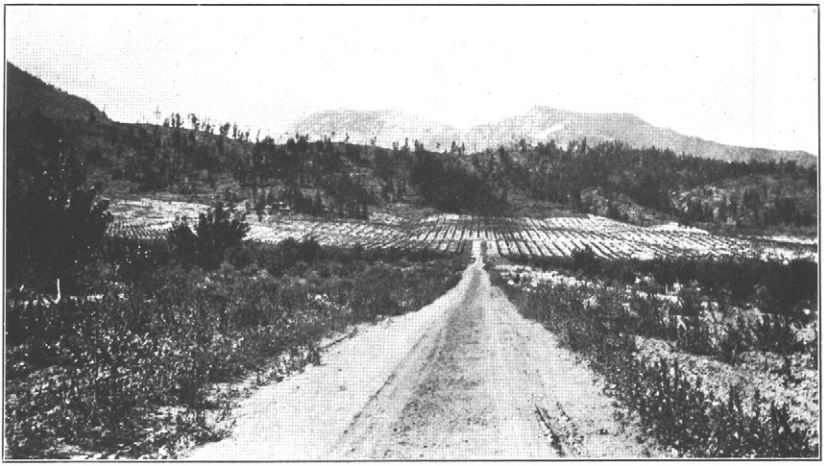
FIG. 2.—LOOKING WEST ACROSS BITTERROOT VALLEY.

Soils of Grantsdale series on terrace in foreground. U-shaped glaciated valleys of Roaring Lion and Sawtooth Canyons in distance.



85324

FIG. 1.—LICK STONY COARSE SANDY LOAM ON GLACIAL MORAINE NEAR MOUTH OF ROARING LION CANYON.



87934

FIG. 2.—SOILS OF BASS SERIES ON GLACIAL OUTWASH TERRACE IN FOREGROUND.

Young orchard planting on lighter colored soils of Lick series at base of stony glacial moraine in distance.

S7935

FIG. 1.—TERRACE MARGIN AND SECTION IN LIGHT-TEXTURED SOILS OF BASS SERIES OCCUPYING GLACIAL OUTWASH FANS OR TERRACES.

S5848

FIG. 2.—VICTOR STONY SANDY LOAM OCCUPYING ALLUVIAL FAN BELOW SAWTOOTH AND ROARING LION CANYONS.

stratum. Beds of gravel and sand underlie all the recent alluvial soils at varying depths. The material forming these soils is derived from a variety of rocks, but mainly from granite, gneiss, and quartzite. The soils have been mapped with the Chamokane, Grantsdale, Waterloo, Corvallis, Colville, and Lolo series. They include some of the most important soils in the area.

The Waterloo and Colville series as encountered in this survey differ somewhat from these series as previously mapped. The Waterloo series, as mapped in Stevens County, Wash., consists of well-drained terrace soils, derived from old lake or river deposits of glacial-outwash origin, while the Colville soils consist typically of recent glacial-lake material deposited as alluvial sediments in a swampy depression of the valley floor resembling the more evident glacial-lake basins occupied by the series in Stevens County. In the present survey the Waterloo soils are mainly well drained, but may include some poorly drained variations, and consist, in part at least, of reworked glacial material.

In addition to the series mentioned two miscellaneous types, Rough broken land and Rough stony land, are shown on the map. These are mainly nonagricultural, but afford some pasturage.

The following table gives the names and actual and relative extent of the various soils mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough stony land	56,640	17.3	Moscow coarse sandy loam	5,760	1.8
Bass stony sandy loam	28,864	9.1	Grantsdale silt loam	5,056	1.5
Eroded phase	1,024		Moscow stony sandy loam	4,928	1.5
Burnt Fork stony loam	12,864	7.8	Ravalli loam [2]	4,800	1.5
Eroded phase	12,736		Bridger gravelly loam	4,800	1.5
Victor stony sandy loam	24,768	7.8	Bass loam	3,904	1.2
Light phase	704		Lolo gravelly loam	3,776	1.2
Waterloo sandy loam [1]	21,248	6.5	Moscow stony loam	3,328	1.0
Corvallis loam [2]	18,496	5.7	Como sandy loam [4]	3,136	1.0
Garrison gravelly sandy loam [3]	16,896	5.2	Bass sandy loam	2,944	.9
Ravalli sandy loam [4]	14,848	4.5	Corvallis silt loam	2,752	.8
Rough broken land	14,720	4.5	Victor stony loam	2,624	.8
Chamokane loam	13,888	4.3	Grantsdale fine sandy loam	2,112	.6
Lick coarse sandy loam [5]	11,008	3.4	Colville silt loam	1,088	.3
Chamokane gravelly sandy loam	9,664	3.0	Burnt Fork loam	1,024	.3
Ravalli silt loam	6,464	2.7	Como silt loam	768	.2
Conglomerate phase	2,432		Bass clay loam	704	.2
Grantsdale loam	6,272	1.9	Total	327,040	

[1] Includes gravelly sandy loam and stony sandy loam of same series.
[2] Includes stony loam of same series.
[3] Includes stony phase of the same type.
[4] Includes stony sandy loam of same series.
[5] Includes stony coarse sandy loam of same series.

Moscow Series.

The soils of the Moscow series are prevailingly brown to dark brown and are underlain by light-brown subsoils resting upon bedrock. In places the subsoil is lacking, the surface soil resting directly upon the bedrock. The soils of the series are primarily of residual origin, derived mainly from granite, gneiss or similar rocks, which underlie them usually at a shallow depth. The upper part of this layer of rock is weathered and disintegrates rapidly. As mapped in this survey, small quantities of undifferentiated material derived from rhyolite schist and quartzite occur in places, and along the line of contact of these soils with the soils derived from old valley-filling deposits an admixture of material from the latter source may also be included. The topography is generally rolling to hilly or rough and broken, although in places the soils occur as smoother, terracelike areas. Drainage is good to excessive. Erosion is more or less active, and deep gullies are numerous. In this area the Moscow series is represented by three types, the coarse sandy loam, stony sandy loam, and stony loam.

Moscow coarse sandy loam.

The Moscow coarse sandy loam is a brown to dark grayish brown, friable, gritty, rather coarse sandy loam of variable depth. Usually this surface material rests directly on bedrock of granite and gneiss at a depth of 18 inches or less, but in places the soil is underlain, at 12 to 20 inches, by a subsoil of similar texture and lighter color. The content of organic matter is low, and the soil is not retentive of moisture. Much mica is present in the soil and subsoil. Though only a few loose stones occur on the surface, rock outcrops are numerous.

Intrusions of narrow dikes of rhyolite occur in the parent rocks of this type at the southern extremity of the valley. Rhyolite does not, however, enter into the formation of the soil to any great extent. Here also the glacial outwash soils of the Bass series, which partly surround this type, have influenced the soil in a small degree.

The Moscow coarse sandy loam is inextensive, forming only a few small areas at the head of the valley in the West Side, and to the east of Threemile Creek and southwest of Florence in the East Side. A small area is also found south of Willow Creek and another southeast of Grantsdale.

The areas generally form eroded foot-hill slopes and in places the sloping breaks of terraces. Drainage is excessive.

Owing to the shallow soil and the rough topography, this type is of little agricultural value. It is used very largely for pasture, especially in the vicinity of Conner. On the areas east of the river

grain is grown to a small extent, but owing to the porous nature of the soil and the lack of water for irrigation the yields are low. Summer fallowing is practiced where grain is grown by dry-farming methods. No fertilizers are used.

Results of a mechanical analysis of a sample of soil of the Moscow coarse sandy loam follow:

Mechanical analysis of Moscow coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470301	Soil	26.6	28.0	10.0	9.6	5.0	15.1	5.6

MOSCOW STONY SANDY LOAM.

The Moscow stony sandy loam consists of a brown to dark grayish brown, gritty, friable, rather coarse sandy loam, with a maximum depth of 18 inches, underlain by a subsoil of lighter brown color, which extends to a depth of about 24 inches. Disintegrating bowlders, usually of large size, are scattered over the surface and outcrops of the bedrock are numerous. The rock fragments and outcrops are usually somewhat rounded, owing to the manner of weathering of the granite. Mica flakes are conspicuous in both soil and subsoil. The areas of deeper soil occur where the slopes are not steep enough to cause the rapid removal of the soil material. The type is deficient in organic matter and unretentive of moisture.

This soil is inextensive, occurring on the foothills of the East Side. The principal areas lie in the vicinity of Weeping Child Creek, Willow Creek, Wheelbarrow Gulch, and along Granite Creek.

The topography is usually rough and broken. Drainage is excessive, and considerable erosion has taken place.

The Moscow stony sandy loam, owing to its light texture, droughty nature, excessive drainage, and stony character, is of low agricultural value. Its principal use is as pasture land. Alfalfa is grown to a small extent under irrigation.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Moscow stony sandy loam:

Mechanical analyses of Moscow stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703100	Soil	12.9	21.9	13.4	18.0	12.0	15.4	6.6
4703101	Subsoil	11.3	22.9	11.9	15.0	9.0	23.4	6.4

MOSCOW STONY LOAM.

The surface soil of the Moscow stony loam consists of a brown to dark grayish brown, gritty, friable loam, from a few inches to 16 inches deep. In most cases the surface soil rests directly upon the bedrock, but in places a brownish subsoil intervenes. Subangular stones or bowlders are usually present and outcrops of granite and sometimes of sedimentary or metamorphosed sedimentary rocks are common. This type is less micaceous than the other types of the Moscow series, but usually contains more organic matter.

The type is inextensive, being developed in several areas of medium size in the vicinity of Grantsdale and Hamilton Heights School. A small area is found also near Como.

The surface ranges from gently sloping to rough and hilly, and is dissected by gulches.

Owing to the difficulty of cultivation, practically all this type is used for grazing. It ranges in value from about $10 to $30 an acre.

Results of a mechanical analysis of a fine-earth sample of the Moscow stony loam are given in the following table:

Mechanical analysis of Moscow stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703105.....	Soil.....	6.0	11.0	10.6	6.7	10.3	46.8	8.4

LICK SERIES.

The soils of the Lick series are light brown in color, often appearing gray on dry, cultivated surfaces (Pl. LXXIII, fig. 2). The subsoils are light reddish brown or yellowish brown to pale yellowish, and are underlain by a substratum of unassorted material of moderately heavy texture and carrying numerous subangular to well-rounded cobbles and bowlders of various sizes, many of which are partially disintegrated. The soils of this series are of glacial ice-laid origin and occur as terminal and lateral moraines, though in places some undifferentiated glacial outwash material may be included. They are derived from granite and gneiss. The material consists of a mixture of bowlders with finer materials, much of which is derived from the weathering of these rocks subsequent to their deposition, and therefore resembles purely residual material. The topography is rolling to steep and hilly (Pl. LXXIII, figs. 1 and 2). Drainage is excessive and erosion severe. Two types of the Lick series are mapped—the coarse sandy loam and the stony coarse sandy loam, the latter being shown on the map by stone symbols in the color used for the coarse sandy loam.

LICK COARSE SANDY LOAM.

The surface soil of the Lick coarse sandy loam is a light grayish brown, somewhat micaceous and generally gritty, loose, porous coarse sandy loam, carrying cobbles and fragments of rock and varying in depth from a few inches to 10 or 12 inches. The subsoil consists of a reddish-brown or light yellowish brown to pale-yellow, heavy coarse sandy loam or sandy loam carrying many weathered bowlders and rocks of granite and gneiss. This material often extends to a depth of 6 feet or more, but the soil may be directly underlain by the more pronounced gravel and bowlder substratum which exists under the type at varying depths. The organic-matter content is low.

The Lick coarse sandy loam is encountered only west of the river. It occurs well up on the mountain slopes, surrounding the mouths of the important canyons from Mill Creek south to the West Fork of the Bitterroot River. The most important areas are developed in the vicinity of Lost Horse, Lick, Rock, and Tin Cup Creeks, and to the south along other streams.

The topography ranges from moderately smooth and steeply sloping to rough and hilly (Pl. LXXIII, fig. 2), and drainage is usually excessive. The type is dissected by the narrow valleys of the streams about which it occurs. Owing to its droughty nature and hilly topography, comparatively little of it is under cultivation. The greater part of it supports a moderately heavy growth of pine. It affords some pasturage, while small areas are planted to orchards (Pl. LXXIII, fig. 2).

In the following table the results of mechanical analyses of samples of the soil and subsoil of this type are given:

Mechanical analyses of Lick coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470306	Soil	19.6	21.6	9.2	13.4	9.2	21.1	5.7
470307	Subsoil	12.6	15.3	8.7	16.2	11.8	25.7	9.9

LICK STONY COARSE SANDY LOAM.

The Lick stony coarse sandy loam is a light grayish brown, light-textured sandy loam, and is underlain by a subsoil of similar or of yellowish-brown color which extends to a depth of 6 feet. The type contains an excess of subangular bowlders, many of which are of very large size. Its organic-matter content and moisture-holding capacity are low.

The topography is steep to hilly and rough (Pl. LXXIII, fig. 1), and drainage is excessive. The type is subject to considerable erosion.

Areas of this type are shown by stone symbol in Lick coarse sandy loam color. The type is of comparatively small extent, and occurs on Mill, Blodgett, and Roaring Lion Creeks.

The Lick stony coarse sandy loam is used to a small extent for grazing, but beyond this it has no agricultural value at present.

Bass Series.

The soils of the Bass series are grayish brown or brownish gray to brown, and the subsoils are light reddish brown to yellowish brown or light grayish brown. Underlying the subsoil there is a stratum of disintegrating granite and gneiss bowlders and cobbles. The soils of this series consist of glacial outwash fan and terrace deposits derived from granite and gneiss. The material is usually stratified or assorted, but imperfectly. (Pl. LXXIV, fig. 1.) The topography is gently to rather steeply sloping or undulating, and drainage is usually well established. (Pl. LXXIII, fig. 2.)

The series is distinguished from the related and associated Como series by the higher content of organic matter in the surface soil and the consequent darker color.

Four types of the Bass series are mapped in this survey—the loam, clay loam, sandy loam, and stony sandy loam, the last having an eroded phase.

Bass sandy loam.

The Bass sandy loam, to a depth of 20 to 36 inches, consists of a brown to dark-brown, heavy, gritty, friable sandy loam. The subsoil is a reddish or yellowish-brown sandy loam, loam or clay loam, underlain by a disintegrating layer of granitic and gneissic cobbles and bowlders at a depth of 48 to 72 inches. The larger bowlders often weigh many tons. This substratum extends to a great depth. The type contains a relatively small percentage of organic matter. There is enough silt and clay in the subsoil to give it a fair water-holding capacity. Medium to large-sized gravel and bowlders are scattered over the surface in places, especially where the type borders the moraines or at the steep margin of the terrace which it occupies, but not in sufficient quantities to interfere seriously with cultivation.

The Bass sandy loam is an important type. It is developed in several areas of fair size in the vicinity of Darby and Como in the southern part of the area. It occupies sloping terraces or alluvial fans extending downward from the low hills or moraines or from the areas of the Como soils toward the river, and giving way to the lower lying soils of the Bass series or to the eroded phase of the Bass stony sandy loam. Surface and underdrainage are good. The type has been affected but little by erosion.

At present the Bass sandy loam is devoted largely to apple growing. The trees appear to be doing well, although few of them are in bearing at the present time. The McIntosh is the most popular variety. The fruit colors well and attains a fair size, and the yields are fairly good.

Sweet cherries have been set out much less extensively than apples. They mature late, are of large size, and usually find a good market. The trees are subject to winterkilling, however, and the buds are sometimes injured by late spring frosts. The orchards are not seriously affected by insects or fungous diseases.

Clean culture and irrigation are practiced in all the orchards. The soil does not require fertilizer as a rule, and therefore little is used.

The value of the land varies but little. Most of it has been sold to nonresidents in 10-acre lots, with trees 5 years old, for $500[1] an acre.

In the following table the average results of mechanical analyses of samples of the soil and subsoil of this type are given:

Mechanical analyses of Bass sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470334, 4703139....	Soil.....	12.2	13.7	6.2	9.1	11.3	37.4	10.1
470335, 4703140....	Subsoil.....	18.6	24.5	8.9	8.4	6.4	27.3	5.8

BASS STONY SANDY LOAM.

The Bass stony sandy loam is typically a brownish-gray or grayish-brown, gritty, friable sandy loam, 16 to 24 inches deep, underlain by a reddish to yellowish-brown sandy loam, in places containing more or less heavy material, which extends to a depth of 30 inches to 4 feet. This merges into a stratum of granitic bowlders extending to great depth. Deposits of clay or of other heavy-textured material of a yellowish to reddish-brown color frequently occur in pockets. Small accumulations of material resembling volcanic ash also were encountered on Canyon Creek. Subangular to rounded bowlders of all sizes are scattered over the surface and throughout the soil and subsoil in sufficient quantities to interfere to some extent with cultivation. The surface soil contains a moderate percentage of organic matter and is fairly retentive of moisture.

In some small areas in which the water table lies close to the surface and drainage is poor, the surface soil contains considerable silt. One small area just north of Sweeny Creek, near the foothills, is underlain at various depths by rhyolite bedrock, which outcrops in

[1] The land values stated throughout the soil descriptions are those prevailing at the time of the survey—1914.

places. Where the type comes in contact with the soils of the Garrison series, notably between Bear and Carlton Creeks, angular fragments of quartz, quartzite, and schist are scattered over the surface, but not in large quantities. In the vicinity of Carlton Creek, where also the soil comes in contact with types of the Garrison series, it is very micaceous and silty.

The Bass stony sandy loam is an extensive and important type. It is confined to the west side of the valley, extending from Carlton Creek on the north to Camas Creek on the south, and occurs as gently sloping to steep outwash fans or terraces.

Drainage is generally very good, and the type is subject to erosion, although it has not suffered greatly therefrom. Practically all of it can be irrigated.

Only a relatively small part of this type is too stony and steep for cultivation, and this still supports the native forest growth of pine and fir. It also affords some pasturage.

This soil is used for general farming crops, orcharding, and grazing. The principal field crops are grain and hay, of which alfalfa forms an important part. Grain is grown under irrigation, and good yields are obtained.

Owing to its eastern exposure, freedom from hardpan, good air drainage, and the abundant supply of water available for irrigation, the type is particularly well suited to orcharding. In many places, notably west of Hamilton, it has been brought to a high state of cultivation. Clean culture is practiced in all orchards. All the varieties of apples, cherries, and pears grown in the valley are found upon this type. Sour cherries are often planted as fillers between the apple trees. While only fair yields are obtained, the fruit is of good size and color and stands shipment well.

Dairying is carried on mainly for the production of butter, and while the industry is not extensively developed, it is being given increasing attention. Good markets are afforded by the two creameries and the cheese factory on the East Side.

The grazing of horses and cattle in connection with general farming is a profitable industry.

Many farmers on this type use barnyard manure and green manuring crops for building up and maintaining the productiveness of the soil. Commercial fertilizer is seldom used.

Land values on the type vary considerably, ranging from $10 to $200 per acre.

Bass stony sandy loam, eroded phase.—The alluvial-fan terraces upon which the Bass series occurs are often terminated by steep, eroded declivities, beginning at 50 to 100 feet or more above the valley floors. Such areas are shown on the map by crosslines and stone symbols as the Bass stony sandy loam, eroded phase.

The soil in these areas varies greatly, both in color and in texture, according to the method of formation and character of parent material. It may consist of material washed from the surface of the terrace, or it may be the weathered gravel substratum of the terrace. In several places outcrops of the outlying granite or rhyolite occur. Usually the finer soil material consists of a dark-brown, heavy sandy loam, about 4 inches in depth. Underlying this, frequently to a depth of 6 feet, the material consists of a heavy, reddish-brown loam, which gives way to the deep, stony and gravelly layer. The content of organic matter is not large.

This phase occurs only on the West Side and in the southern part of the area, skirting the main valley as well as the tributary valleys. Its only agricultural value is in the little pasturage it affords.

Average results of mechanical analyses of fine-earth samples of the soil and subsoil of the typical Bass stony sandy loam follow:

Mechanical analyses of Bass stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470336, 470343.....	Soil.....	18.9	24.2	10.4	12.7	6.2	17.4	9.9
470337, 470344.....	Subsoil.....	13.2	20.9	13.3	23.3	10.9	12.1	6.2

BASS LOAM.

The surface soil of the Bass loam consists of a brown, medium to heavy friable loam, about 20 inches in depth. The subsoil is a reddish or yellowish-brown, compact loam or sandy loam, which extends to a depth of 3 feet or more. Both soil and subsoil contain a small quantity of mica. The entire type is underlain by the gravel and bowlder substratum characteristic of the Bass series. A few cobblestones occur on the surface near the moraines, but these interfere little with cultivation. The content of organic matter is somewhat greater than in the sandy loam of the same series.

The Bass loam occupies parts of the fans or terraces upon which the sandy loam occurs. All the type lies west of the river and in the southern part of the area. The surface is smooth and of varying slope, but is never too steep for irrigation or cultivation. The gravel wash giving rise to the terraces occupied by this type in the vicinity of Conner School was deposited around low hills of granite and rhyolite, leaving only their summits and eastern sides exposed.

As seen from the valley, the areas of Bass loam are irregular and indented, owing to the gullied and eroded terraces. The type is well drained, and drainage water often seeps to the valley floor. Deep gulches and gorges dissect the type.

Most of this type is now under cultivation, being used for general farming and orcharding. Uncultivated areas are still covered with

the virgin forest growth of pine and fir. The apple is the most extensively grown fruit, the McIntosh being the most popular variety. Owing to the heavier texture of this soil, it is somewhat better suited to apples than the sandy loam of the same series. Fair yields are obtained and the fruit is of good color, size, and quality. The orchards have been brought to a high state of cultivation under the system of clean culture and irrigation.

Land of this type has about the same value as that of the Bass sandy loam. Grain and hay are important crops on the areas of this type south of Tin Cup Creek. Very little of the type is used for grazing.

Mechanical analyses of samples of the soil and subsoil of the Bass loam are given in the following table:

Mechanical analyses of Bass loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470328	Soil	10.6	9.0	3.8	7.6	16.6	41.9	10.5
470329	Subsoil	18.6	19.4	10.4	17.4	10.8	16.3	7.2

BASS CLAY LOAM.

The Bass clay loam consists of a grayish-brown, rather heavy, silty clay loam, about 12 inches deep, which becomes darker in color and in places sticky when wet. The subsoil is a reddish-brown sandy clay which is inclined to become compact and hard upon drying out. Ordinarily but little mica is present in the soil. It is relatively high in organic matter. The gravel and cobble stratum characteristic of the Bass series underlies this type at a depth of 3 to 6 feet and extends to great depths. Both soil and subsoil are very retentive of moisture.

The Bass clay loam is of small extent, and is developed in three areas near Darby, along the edge of the terrace occupied largely by the other types of the Bass series. The surface is that of a gently sloping fan, located well above the valley floor. Drainage is good.

The type is used largely for the production of apples with clean cultivation and irrigation. The McIntosh is the most popular variety. No fertilizer is used.

Land of this type, with bearing orchards, has been sold at $500 an acre. There was no unimproved farm land for sale at the time the survey was in progress.

Because of the light fall of snow in the valley, the use of winter cover crops, especially the legumes, is very beneficial. Care is necessary to prevent the drying and subsequent baking and hardening of the subsoil.

Como Series.

The soils of the Como series are of light grayish brown or brownish-gray color, the gray tint being most pronounced in air-dry cultivated surfaces. The upper part of the subsoil is lighter in color than the soils, becoming yellower or faintly reddish brown in the lower part. The subsoils are usually somewhat heavier than the surface soils, and have frequently been influenced somewhat in texture, structure, and color by weathering, in place, of an included or underlying granitic cobble and bowlder substratum, which may, however, give way to strata or lenses of loose sands and gravels. The soils of this series are derived from old valley-filling deposits occupying sloping to undulating and eroded alluvial fans and terraces and probably deposited by glacial streams, the material being imperfectly stratified or assorted. Drainage is well developed to excessive. The soils of this series are distinguished from the associated soils of the Bass series, which they resemble in origin, mode of formation, topography, and character of subsoil and substratum, by a lower organic-matter content and lighter color of the surface soils. Three types are mapped in this area—the sandy loam, stony sandy loam, and silt loam.

Como sandy loam.

The soil of the Como sandy loam is a light grayish brown, medium to rather fine textured, porous sandy loam, about 12 inches deep. The subsoil is a compact, moderately heavy sandy loam or loam, underlain at a depth of 4 to 6 feet by the stony, gravelly stratum characteristic of the terraces of the West Side. The surface soil contains but little organic matter and mica and is droughty. Large stones are scattered over the surface in places, especially where the type borders the moraine, and both soil and subsoil contain large quantities of grit.

This type is inextensive, one area occurring along Bunkhouse Creek and one north of Hays Creek in the southern part of the survey. The surface is rather smooth and usually sloping. In the area north of Hays Creek the surface is not so uniform as on the other area, which resembles a series of low, moderate to steeply sloping terraces.

Drainage is excessive and most of the type is dissected by the channels of small, intermittent streams.

While the Como sandy loam is not so well suited to orcharding as the soils of the Bass series, owing to its greater slope and more droughty nature, it is used almost entirely for apple orchards. None of these have yet come into bearing.

The same methods of irrigation and cultivation are used on this type as on the Bass soils. More water is necessary, however, and greater care must be exercised to prevent erosion of the surface soil.

The growing and turning under of winter cover crops is very beneficial. Commercial fertilizer is not used on this type.

Orchards on this type containing 3-year-old to 5-year-old trees are valued at about the same price as on the Bass series.

Mechanical analyses of samples of the soil and subsoil of the Como sandy loam follow:

Mechanical analyses of Como sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703133	Soil	13.6	14.4	6.6	11.0	13.0	36.6	4.9
4703134	Subsoil	7.8	11.2	6.3	11.4	14.4	36.0	13.0

COMO STONY SANDY LOAM.

The Como stony sandy loam, which is differentiated upon the map from the Como sandy loam by stone symbols, consists of a stony sandy loam of a light grayish brown to brown color, with an average depth of 12 to 14 inches. The subsoil is a light-gray or light grayish brown to light yellowish brown gritty sandy loam or heavy fine sandy loam, which is underlain at a depth of 2 to 4 feet by a stony or gravelly stratum or by bedrock. Both soil and subsoil are porous, gritty, and irretentive of moisture. Angular fragments of various sizes and consisting largely of granite and gneiss are frequent in the surface soil. Near the small drainage ways small rounded cobbles occur. Rock outcrop is seldom encountered.

Areas of Como stony sandy loam were encountered in three places—southwest of Woodside, west of Hamilton, and southwest of Truman.

The surface is that of a moderately smooth but rather steep mountain foot slope. It is dissected by a few minor drainage ways. The surface and subdrainage are excessive. This type lies higher than the soils of the Bass series, with which it merges.

Owing to the difficulty of cultivating and irrigating this soil, it has very little value other than for grazing. The price of the land is variable.

In the following table the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Como stony sandy loam are given:

Mechanical analyses of Como stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470356	Soil	8.6	13.2	6.6	14.0	13.2	37.4	6.6
470357	Subsoil	10.8	16.4	10.0	18.9	12.1	26.2	5.7

COMO SILT LOAM.

The surface soil of the Como silt loam as typically developed is a light grayish brown, somewhat micaceous, compact, silty loam, 20 to 24 inches deep. The subsoil is a reddish-brown to yellowish-brown, compact, somewhat gritty silty clay loam, which is underlain at a depth of 36 to 48 inches by a deep stratum of partially disintegrated gravel and bowlders of granite and gneiss. The soil is low in organic matter and becomes sticky when wet. The surface is practically free from grit and fragments of rock, except at the edge of the steep slope which extends to the valley, where a few smooth, well-rounded cobbles, generally of granite or quartzite, occur.

This type occupies a sloping, fanlike terrace with a smooth and even surface, resembling that of the Bass loam. It is dissected by a few minor gullies, but the surface as a whole is fairly uniform and is well suited to irrigation and cultivation. Drainage is good, but the heavier subsoil of this type does not allow water to percolate so rapidly as that of the Bass loam. The only area mapped in the Bitterroot Valley occurs northwest of Conner.

The original forest growth consisted of pine, but practically all the type is now cleared and under cultivation. It is used mainly for grain farming under irrigation, wheat being the chief crop. The average yield of wheat is about 30 to 35 bushels per acre. A small acreage is used for grazing, chiefly for horses.

On account of its eastern exposure and high position, the type is well suited to the production of apples, small fruits, and berries. There are no commercial orchards on the type.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Como silt loam:

Mechanical analyses of Como silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470302	Soil	1.0	1.0	0.8	3.2	12.0	71.4	10.9
470303	Subsoil	6.2	5.0	3.0	5.2	8.8	42.4	29.6

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470303, 0.79 per cent.

BRIDGER SERIES.

The soils of the Bridger series are dark gray or dark brownish gray to black and are underlain by sticky, compact, and often calcareous subsoils of light-gray or yellow color. The soils and subsoils contain gravel which varies from fine angular chips to large, well-rounded bowlders, angular blocks, and cobblestones. The type occurs

upon mountain and lower foothill slopes, higher sloping plains, mesa lands, and alluvial fans. It occupies small, irregular to broad, extensive areas. The soils consist of alluvial-fan and alluvial-slope deposits, distributed by streams or by surface wash. The higher lying areas are marked by rock outcrop or bowlders and are deeply cut by stream channels. The soils are treeless or sparsely timbered, except in the vicinity of streams. The materials forming the soils are derived from granitic or volcanic rocks, with an admixture from sedimentary rocks. The soils are well drained and are retentive of moisture. The series is represented in this area by one type, the Bridger gravelly loam.

BRIDGER GRAVELLY LOAM.

The soil of the Bridger gravelly loam to a depth of 10 to 16 inches consists of a very dark gray or dark brownish gray loam, carrying varying quantities of subangular to rounded gravel and resting upon a subsoil of grayish-brown or yellowish-brown to reddish-brown calcareous fine sandy loam or loam, which usually extends to a depth of more than 6 feet. The surface soil is of rather light texture, approaching a sandy loam in places, but is fairly compact in structure and retentive of moisture. The subsoil carries considerable silt and is very compact. The upper subsoil also carries gravel and stones, especially along the stream courses. Pockets of material resembling volcanic ash are occasionally seen in cuts. In places a grayish to yellowish-brown or reddish-brown calcareous hardpan layer in which more or less stratification appears is encountered at a depth of 1 foot to several feet. The soil contains a fair percentage of organic matter.

The Bridger gravelly loam occurs as a single large area lying south of Eightmile and Granite Creeks.

The type descends from the residual hills of granite on the east toward the valley with a fairly uniform surface and good grade. Remnants of old shore or terrace lines exist in many places. The type, except along the drainage ways, where erosion has rendered it rough and stony, lies well for cultivation. Drainage is good to excessive.

The larger part of the type lies above irrigation ditches and is used for pasture. Dry-farmed wheat is grown to some extent, the land being fallowed every other year. Fall wheat of hard varieties is sown chiefly. The grain produced is of good quality, and the yield ranges from 30 to 45 bushels per acre. Little or no fertilizer or barnyard manure is used. The rougher and stonier parts of the type have no value except for the scant pasturage they afford.

The price of land ranges from $20 to $75 an acre, depending upon ease of cultivation, topography, and distance from the valley.

Following are the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Bridger gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470376	Soil	5.8	8.2	5.2	14.4	19.4	36.2	10.9
470377	Subsoil	4.0	6.1	3.4	12.4	30.2	30.6	13.2

BURNT FORK SERIES.

The soils of the Burnt Fork series are of dark brownish gray to dark-gray color, and are underlain by medium brownish gray or light-gray, calcareous subsoils, which are typically heavier and more compact than the surface soils. These are usually gravelly and the upper part is cemented into a soft, calcareous conglomeratelike hardpan. These may be underlain by a deeper substratum of finer clay or silty clay sediments of yellowish or pinkish color. The soils of this series are derived from old valley-filling deposits occupying elevated and frequently eroded terraces, old alluvial fans or filled-valley plains. The surface is generally smooth and gently sloping, but where eroded may be steep and broken. The material forming these soils is derived from a variety of rocks. The series is differentiated from the Bridger series by difference of color and by the uniform occurrence of hardpan. The series is represented in this area by two types—the stony loam, with an eroded phase, and the loam.

BURNT FORK STONY LOAM.

The Burnt Fork stony loam is a dark-gray or dark grayish brown, rather gritty, light-textured, friable loam, from 10 to 15 inches deep, resting directly upon a moderately well to softly cemented, calcareous hardpan, carrying large quantities of well-rounded, smooth quartzite and granite cobbles, and varying in thickness from a few inches to a foot or more. The subsoil is a light-gray to light reddish brown or yellowish-brown fine sandy loam, extending to 6 feet or more, also carrying quartzite and granite cobbles and bowlders. In places the subsoil is finer in texture, more compact, and shows seams of calcareous material. The surface soil contains a fair percentage of organic matter and retains moisture fairly well. In places it contains small quantities of mica. The type is fairly uniform throughout. In places near the foothills the type overlies granite bedrock.

This type lies east of the river, being developed in areas of good size, extending from a point south of Grantsdale almost to Eightmile Creek. It occupies high terraces, often several hundred feet above the valley floors. The most typical area is that forming the great

benches of Burnt Fork. Another large area occurs east of Hamilton. These terraces extend from the mountain slopes on the east toward the recent valley of the Bitterroot River on the west, to which they drop by an abrupt slope.

The topography is smooth and gently sloping, and the drainage is well developed. Around the edges of the terraces some erosion has taken place and a few gullies have been formed.

Burnt Fork stony loam is a very important agricultural type. Owing to its high position, it is well suited to the production of fruits. All the varieties of fruit grown in the valley are found on the type. While the yields are not very large, the fruit is of good color, size, and quality. Apple and cherry orchards have been set out extensively. Where the calcareous stony layer is broken up sufficiently to allow the roots to penetrate the subsoil the trees make a fair growth, but if this is not properly done the trees die before coming into bearing. The orchards have been brought to a high state of cultivation. Clean culture and irrigation are practiced. Owing to the western exposure of this type orchards are likely to winterkill unless cover crops are grown.

Wheat and oats are grown on this type east of Hamilton. Under irrigation yields of 35 to 40 bushels of wheat and 50 to 60 bushels of oats per acre are produced. Alfalfa is also grown to some extent, yielding 2½ to 3½ tons of hay per acre. After the alfalfa has been harvested the fields are used to pasture horses and cattle. A part of the type is in permanent pastures, which are usually irrigated.

In cultivating this soil barnyard manure and green crops are sometimes plowed under during the summer, but no commercial fertilizer is used.

The price of land of this type, supporting 5-year-old orchard trees, is $500 an acre. Where the land is sold for general farming the price ranges from $50 to $150 an acre, depending upon location, freedom from surface stones, and the depth of the surface soil.

Burnt Fork stony loam, eroded phase.—The surface soil of the Burnt Fork stony loam, eroded phase, varies considerably in color and texture. It is predominantly a dark grayish brown loam, 6 to 8 inches deep, containing a large percentage of gravel and stones. In some places it contains considerable material washed from the higher lying soils, while in others it may be composed entirely of a mass of sand and gravel which has been slowly brought down the slope by the action of gravity and water. The subsoil usually is light grayish brown to light brown or yellowish brown in color and extends to a depth of 6 feet or more. While it contains some heavy sandy loam or loam and is generally similar to the subsoil of the main type, it may be much lighter in texture and very open and porous in structure. The calcareous hardpan layer found in the

main type is entirely lacking in the phase. In places the surface material has been removed and the subsoil exposed. The phase usually contains less organic matter than the typical soil and is only slightly retentive of moisture. Waterworn fragments of granite and quartzite are scattered throughout both soil and subsoil.

Areas of this phase surround the old high terraces of the streams of the East Side. One area, however, was encountered northwest of Victor on the West Side. Here it contains large, rounded quartzite cobbles similar to those on the typical areas along Burnt Fork, and it is not unlikely that this area was part of the great deposit of the benches of Burnt Fork, left after erosion by the Bitterroot River had segregated it from the main body on the East Side. The phase has a rough, eroded, and steep topography and only a very small part of it is suited to irrigation or cultivation. Drainage is always excessive.

Agriculturally the phase is of no importance. In places orchards extend slightly over the boundary separating the phase from the areas of the typical soil, and pines continue to grow where they obtained a foothold years ago. A part of the phase also affords scant pasturage. Where fruit trees have been set out they have made a very poor growth.

The price of this land is very low, except where used for orchards. In general, it takes its value from the type with which it is sold.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the typical Burnt Fork stony loam:

Mechanical analyses of Burnt Fork stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703108	Soil	4.6	10.0	6.0	10.6	13.8	46.2	8.7
4703109	Subsoil	6.6	10.0	4.3	9.6	25.3	36.2	7.9

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 4703109, 2.25 per cent.

BURNT FORK LOAM.

The soil of the Burnt Fork loam is darker in color and deeper than that of the stony loam of the same series. It is typically a dark brownish gray, moderately heavy, compact loam, from 12 to 24 inches deep, containing a large percentage of silt and organic matter. Immediately underlying the surface soil is a feebly cemented calcareous, hardpan of a light-gray color, varying from several inches to several feet in thickness. This layer is impervious to moisture and must be fractured to allow the roots of plants to reach into the subsoil.

It softens on exposure to air and moisture. The subsoil, which extends to 6 feet or more, is a light grayish brown or pale reddish brown to light brownish gray, compact, silty fine sandy loam, containing some lime. In places the subsoil is mottled. Rounded cobbles and stones are encountered in many places in both soil and subsoil. Owing to its heavier texture, this soil is more retentive of moisture than the other types of the Burnt Fork series.

Only one area of the Burnt Fork loam is mapped. This occurs about 2 miles east of Grantsdale, occupying a high terrace which descends from the foothills on the east and approaches the valley soils or the stony loam of the Waterloo series through a steep slope of 50 to 100 feet.

Surface drainage is good, except in spots where there is a high water table. In such spots the soil is darker than usual, owing to the higher content of organic matter.

The surface of the Burnt Fork loam is smooth and the type is easily cultivated. It is a good general farming soil, and all under cultivation. The chief crops are alfalfa, oats, wheat, and peas. Oats, which are grown much more extensively than any other grain, yield from 50 to 75 bushels per acre and wheat from 35 to 50 bushels. Peas yield 20 to 25 bushels of seed and alfalfa 4 tons or more of hay per acre. Clover also is grown to some extent for hay. The type is well suited to orchard fruits, although no orchards are set out on it. Irrigation water is obtained from Skalkaho Creek. No commercial fertilizer is used.

The value of the Burnt Fork loam ranges from $60 to $150 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Burnt Fork loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703102	Soil	4.8	9.2	5.9	10.4	13.3	46.6	9.6
4703103	Subsoil	4.1	9.3	5.6	11.2	21.3	40.6	7.6

RAVALLI SERIES.

The soils of the Ravalli series are a light to medium grayish brown, sometimes becoming light gray on dry, exposed surfaces. The subsoils are light gray, light grayish brown or yellowish brown in color and calcareous in character. They are usually heavier in texture and more compact in structure than the surface soils, in places approximating hardpan, and are underlain by a deep layer of stratified yellowish or pinkish clay and silt. The series is derived from

old valley-filling deposits, the materials of which come from many different kinds of rocks. The underlying silt and clay are probably of lake-laid origin. The surface ranges from nearly level and gently sloping to undulating or eroded, with steep slopes where cut by dissecting streams. The members of the series are differentiated from the Burnt Fork series by the lighter color of the soils. Drainage is well established.

In this area the series is represented by five types—the sandy loam, stony sandy loam, silt loam with a conglomerate phase, loam, and stony loam.

RAVALLI SANDY LOAM.

The soil of the Ravalli sandy loam, to a depth of about 10 inches, is a light grayish brown to light-brown, moderately compact, heavy sandy loam, appearing light gray upon dry, exposed surfaces. The subsoil is a light-gray to yellowish-brown or light-brown, rather compact, sticky sandy loam, somewhat more micaceous than the surface soil, and extending to a depth of 6 feet or more. A plowsole occurs beneath the surface soil in places. In cuts and eroded portions of the type some lenses of volcanic ash of light-gray color are frequently observed. Stones of various sizes are occasionally encountered scattered over the surface, being particularly noticeable along the foothills near Ambrose School, and the subsoil in places contains some gravel. Both soil and subsoil contain a small percentage of lime. The soil has only a fair content of organic matter and is not very retentive of moisture.

The Ravalli sandy loam is not an extensive type. The principal areas are located in the foothills south of Ambrose Creek and east of Lone Rock School. The surface of the type is that characteristic of the foothill slopes and higher old alluvial fans, the greater part of it being dissected and eroded. Drainage is good to excessive.

This type has little value except as pasture land. A small part of it is used for the production of grains, and a few orchards have been set out. It is not so well suited to fruit growing as the other soils of the Ravalli series. The price of farm land ranges from $25 to $100 an acre.

The results of mechanical analyses of samples of the soil and subsoil of this type follow:

Mechanical analyses of Ravalli sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703115	Soil	10.4	16.1	8.4	18.0	18.0	23.0	5.9
4703116	Subsoil	7.6	9.9	6.4	19.1	27.4	22.6	6.8

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 4703116, 0.65 per cent.

RAVALLI STONY SANDY LOAM.

The fine earth of the Ravalli stony sandy loam, which type is shown by stone symbols in Ravalli sandy loam color, consists of a light-gray to grayish-brown, moderately compact, gritty, calcareous, sandy loam. The interstitial material of the subsoil is a grayish-brown or light brownish gray to light reddish brown, sticky, calcareous sandy loam. The soil is 8 to 15 inches deep and the subsoil extends to 6 feet or more. In places a hardpan layer lies beneath the subsoil. Both soil and subsoil contain a large quantity of rock fragments of various sizes. Deposits of gray volcanic ash also occur in places. The organic-matter content of the type is greater than that of the silt loam or loam, but is only moderately large. The soil is not very micaceous.

This type is confined to the East Side, the largest areas extending from Willow Creek to Granite Creek.

The surface is rolling to steep and hilly, and drainage is well established. Gulches and creeks dissect the surface.

The greater part of the type is unused except as pasture land. On the areas east of Corvallis and Victor orchards have been set out, and in some other sections grain is grown to a small extent. Owing to the abundance of stones, the soil is very difficult to cultivate.

Apples are the principal orchard fruit. Where the stones are removed the type is as well suited to orcharding as many of the other stony types of the area. Fair yields can be obtained and the fruit is of good quality and size. As on the other soils of the valley, clean culture is practiced. No fertilizer is used at present. The value of land on which orchards have been set out is about the same as for other types.

In the following table the results of mechanical analyses of fine-earth samples of the soil and subsoil are given.

Mechanical analyses of Ravalli stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703121	Soil	10.2	13.2	5.0	9.0	17.0	37.0	8.6
4703122	Subsoil	11.4	10.9	5.0	12.8	14.0	36.4	9.7

RAVALLI SILT LOAM.

The surface soil of the Ravalli silt loam consists of a light brownish gray to light grayish brown, smooth, sticky, silty loam, from 8 to 12 inches deep. The subsoil is a light yellowish gray to light grayish brown, rather sticky, and compact, calcareous loam to clay loam, which frequently contains some mica. Immediately underly-

ing the surface soil there is a light-grayish to reddish-brown, compacted subsurface stratum, which is locally called hardpan, although only feebly, if at all, cemented. The true cemented hardpan, which characterizes the series locally, usually occurs at a greater depth than 6 feet and ranges from several inches to several feet in thickness. Pockets of volcanic ash of a light-gray color occur at varying depths. The surface soil is generally uniform in color, but the subsoil varies considerably. Where exposed in cuts it is frequently light reddish brown in color and of an adobelike structure, and is underlain by deep, stratified material consisting of fine sand, silt, and clay. In places coarse, gritty material is present in the surface soil, especially in areas associated with soils of the Moscow series. Stones are frequently encountered on the surface, especially along the contact with the stony types. The content of organic matter is low.

The Ravalli silt loam occurs in numerous small areas on the slopes of the East Side. The surface ranges from gently sloping to steep and eroded, and drainage is good to excessive.

The Ravalli silt loam is used extensively for the production of dry-farmed grain. Commercial orcharding also is important. Much of the type lying too high for irrigation is used for pasture or for the production of wheat. Little of the type on the south side of Burnt Fork has orchards on it.

Where grain is produced without irrigation the land must be fallowed every other year. The ordinary yield of wheat under this method is 20 to 30 bushels per acre. Both winter and spring varieties of hard wheat are grown, and the grain is of good commercial quality. No commercial fertilizer and very little manure is used on this type.

Because of the lack of moisture the pasturage afforded by this type is scanty, making it necessary for stock to range over large areas. A few small streams supply water for the stock.

The value of the land varies considerably, depending largely upon its topography and its distance from developed sections of the valley. While trails lead to all parts of the type, these are often steep and eroded. The price of farm land not in orchards ranges from $20 to $75 an acre. Where orchards have been set out, the value is about that of other orchard land in the valley.

Owing to its shallow surface soil and low organic-matter content, this type is irretentive of moisture. In many places its productiveness can be increased by breaking the compact subsurface layer with a subsoil plow.

Ravalli silt loam, conglomerate phase.—The conglomerate phase of the Ravalli silt loam differs from the main type chiefly in the presence of a subsurface layer of hard, conglomeratic material. The soil is light grayish brown, often becoming light gray on dry

surfaces, and from 6 to 12 inches in depth. Where the hard conglomerate layer does not directly underlie the soil at a shallow depth a subsoil similar to that of the typical soil is present. The conglomerate varies greatly both in thickness and in the depth at which it underlies the soil. Out in the valley it is frequently only a few inches in thickness, while near the foothills it may be several feet thick. It is underlain by the usual stratified pinkish sediments.

In topography and drainage the phase is similar to the typical soil. In places it is equal in value to the typical soil; in others it is practically worthless, depending entirely upon the depth of the surface soil and the thickness of the conglomerate stratum. Some of the land is used for orcharding and grain farming, and a part of it for pasture. The grasses make a scanty growth. Near the foothills, where the soil is fairly deep, grain does well. Where the conglomerate layer lies near the surface, orchard trees do not attain a normal growth.

Average results of mechanical analyses of samples of the typical soil and subsoil follow:

Mechanical analyses of Ravalli silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703117, 4703119...	Soil.....	1.4	2.7	1.9	5.6	24.3	57.0	7.1
4703118, 4703120...	Subsoil.....	1.8	3.2	2.3	7.1	24.0	52.9	8.6

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 4703118, 6.11 per cent.

RAVALLI LOAM.

The Ravalli loam differs little from the Ravalli silt loam except in texture. The surface soil consists of 8 to 12 inches of a light grayish brown loam, and the subsoil of a light-gray to light grayish brown or yellowish-brown, somewhat gritty, calcareous loam or clay loam, which extends to a depth of more than 6 feet. Where irrigation and cultivation have not disintegrated it, a reddish-brown, semicemented layer directly underlies the soil. In many places a true red hardpan occurs, but usually at some depth. This often shows stratification and extends to great depths. The subsoil is more micaceous than the soil. Occasional pockets of volcanic ash are encountered in the substratum. Both soil and subsoil are compact and very retentive of moisture. The organic-matter content of the type is low. The soil is generally uniform, but in places the surface soil has been removed and the subsoils exposed. Fragments of quartzite, quartz, and granite occur on the surface where this type comes in contact with the stony types.

The Ravalli loam is inextensive and is confined to the valley east of the river. It lies lower than the silt loam. The largest areas occur along the south side of Willoughby Creek.

While in places the type has a smoothly sloping surface, as a whole it is rolling and dissected. Deep gulches, most of which only occasionally carry water, provide perfect drainage.

A large part of this type is under cultivation. Areas too rough and eroded for farming afford scant pasturage. Many of the orchards on this soil are situated in the area east of Riverside. Apples and cherries are grown. These do somewhat better on this type than on the silt loam of the same series. That part of the type west of Rosemont, which lies too high for irrigation, is devoted almost entirely to the production of wheat, the yields ranging from 20 to 40 bushels per acre. The same cultural methods are followed on this type as in other sections of the valley. The price of land suitable for grain growing ranges from $20 to $75 an acre. Land in orchards has about the same value as other types similarly improved.

Deep plowing and the incorporation of organic matter in the form of stable manure or green-manure crops are necessary for best results on this soil. Where shallow plowing is persisted in for a number of years a plowsole sufficiently compact to retard root development is formed.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Ravalli loam:

Mechanical analyses of Ravalli loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470398	Soil	4.3	8.4	5.4	9.3	15.9	45.7	10.5
470399	Subsoil	1.4	4.1	3.1	8.4	26.5	42.9	13.4

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470399, 3.25 per cent.

RAVALLI STONY LOAM.

The Ravalli stony loam, which is indicated upon the soil map by stone symbols over the Ravalli loam color, is very similar to the loam in all respects, except as to the quantity of stones present in the material. Where typically developed it consists of a light-gray or grayish-brown, somewhat micaceous, gritty loam, underlain at a depth of 8 to 10 inches by a light-grayish or yellowish-gray to light reddish brown, gritty calcareous loam to clay loam, more than 6 feet in depth. One or more hard, cemented layers of varying thickness occur in the subsoil or substratum. As seen in cuts, the subsoil has a grayish or reddish-brown appearance and an adobelike structure and con-

tains occasional pockets of gray volcanic ash. Rounded to subangular fragments of granite, quartzite, and quartz of all sizes are scattered over the surface and embedded in the soil material. The subsoil may be free from stones or these may be present to a great depth. The soil is deficient in organic matter, but is fairly compact and retains moisture well. The Ravalli stony loam does not present many variations, except in the color of the subsoil. In places the surface material has been removed by erosion and the lighter colored subsoil exposed. The subsoil is more micaceous than the soil.

The type is not very extensive. The principal areas occur in the vicinity of Hamilton Heights School and about 1½ miles east of Corvallis. The topography is gently sloping to rolling or hilly and the drainage is good. The surface is more or less dissected and eroded.

Nearly all this type, where the topography is suitable, has been set out to apple and sweet-cherry orchards. The trees are young, but the fruit which they have borne is of good quality and size, and the indications are that when the orchards come into full bearing somewhat heavier yields will be obtained than on types of lighter texture. Winterkilling is probably less frequent or severe on this type than on types of lighter texture. A small acreage of alfalfa is grown.

Clean culture and irrigation are practiced on this type. Little or no commercial fertilizer is used.

The physical condition of this soil can be greatly improved by plowing under organic matter, including crops grown as winter cover.

The value of orchard land of this type, bearing 5-year-old trees, is the same as that of other orchard soils of the valley, the usual price being $500 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Ravalli stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470396	Soil	6.9	12.7	6.6	10.6	15.2	37.5	10.0
470397	Subsoil	4.6	8.4	4.9	13.9	24.0	35.2	9.0

The following sample contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470397, 2.70 per cent.

VICTOR SERIES.

The soils of the Victor series are dark gray, dark brownish gray or dark grayish brown, the lighter color occurring in areas of lower organic-matter content. The subsoils are of a lighter gray-

ish brown or yellowish-brown color. In places they have been modified locally by the addition of the weathered products of an underlying gravel and bowlder stratum. The members of the series are derived from recent alluvial-fan deposits derived from granitic or gneissic rocks. In the lower part of the valley, in the neighborhood of Victor, quartz and quartzite cobbles are frequently encountered on the surface, but these do not occur in sufficient quantity to have any apparent influence on the soil. The soils have been distributed as broad sheets by torrential, shifting streams emerging from adjacent mountain canyons. (Pl. LXXIV, fig. 2.) In this survey small areas confined to narrow stream valleys cut into older glacial deposits have been included and recognized as stream-bottom variations. The types of the series are usually of good slope and well drained, and subdrainage is frequently excessive on account of the porous substratum. The surface is generally smooth. Unlike the higher, eroded fans of the glacial-outwash deposits, the material is being added to from time to time by sediment brought down by mountain streams. The soils are usually traversed by perennial streams and usually are favorably situated for irrigation, but owing to their shallow and, in places, excessively stony and porous character, they are more or less droughty. In this area two types are mapped—the stony sandy loam, with a light phase, and the stony loam.

VICTOR STONY SANDY LOAM.

The Victor stony sandy loam is a gray to dark-gray or dark grayish brown, gritty, heavy sandy loam, from 10 to 20 inches in depth, resting on a gritty sandy loam subsoil which contains considerable gravel and stones and extends to a depth of from 2 to 6 feet or more. The stony and gravelly character of the subsoil material is due in part to disintegration of included granite and gneiss bowlders. In fresh cuts the subsoil has a yellowish to reddish-brown color. Where exposed along streams it has the appearance of a very light brown or light grayish brown stony sand. A porous bowlder and gravel stratum underlies the subsoil, extending to unknown depths. The type is fairly uniform throughout the area. On approaching the trough of the valley the soil mantle increases somewhat in depth and in content of silt and clay. Only a moderate quantity of organic matter is usually present. The type generally shows partial stratification (Pl. LXXIV, fig. 2). The stones generally consist of well-rounded fragments of granite and gneiss and vary considerably in quantity and size, being most numerous over those areas about the canyons having typical moraines lying at their mouths. This division can be made roughly at Fred Burr Creek, that part of the type lying to the south carrying more stones than the part to the north.

The Victor stony sandy loam, which is the most important and extensive type of the Victor series, lies entirely on the west side of the river, extending from near Conner School on the south to Carlton Creek on the north. The areas are more or less fan shaped, often beginning at the canyon mouth, where they are narrow, and sloping toward the Bitterroot River, where they form a moderately high bank, or to the river terraces, into which they merge but from which they are readily distinguished. South of Camas Creek the areas of this type occur in narrow, deep valleys, intrenched in the older glacial material and extending from the canyon mouth to the river, where they merge with the terraces of the latter. The surface is uniform and is well suited to irrigation but stony. The stones increase in size and quantity as one ascends the slopes, and on the upper or western part much of the land is unsuited to agriculture. The type is dissected by perennial streams with narrow, shallow channels. Drainage usually is good, although along the small stream courses a few poorly drained areas occur and at times local areas, affected by seepage from higher sources and with high water table, are found.

This type is not very extensively used for farming. Forests of pine formerly covered the entire area, and these still occupy the more stony areas. Where cultivated the type is used chiefly for general farming. It is also largely used as pasture land, to which it is well suited, as it produces a good growth of grass and has an abundant water supply. Dairying is carried on in connection with general farming.

Wheat, oats, and alfalfa yield well under irrigation. The yields of wheat and oats are lower than those on the Grantsdale silt loam, but they are above the average for the valley.

Alfalfa is grown to a small extent, making satisfactory yields. Two cuttings are obtained in a season, after which stock is pastured in the fields.

There are some apple and crab-apple orchards on the type, although it is not generally used for orcharding, as it lies in the path of the cold-air currents from the canyons and higher lying areas, and injury is more likely to result from frost, except in protected locations.

All crops are grown under irrigation. The orchards are given clean cultivation. No commercial fertilizer and only a small quantity of barnyard manure is used. The value of land of this type ranges from $15 to $150 an acre, depending upon its location and ease of cultivation.

In places the type contains somewhat less stones and bowlders than usual, and the larger stones are absent. Here also the depth of the soil and subsoil material is usually somewhat greater than typical, the organic-matter content slightly higher, and the water-

holding capacity greater. Such areas always lie on the lower slopes of the alluvial fans. Three small areas of this description occur between Mill Creek and Carlton Creek. Here drainage is generally good, irrigation and cultivation are easier, and all crops do better than on the more stony areas of the typical soil.

Victor stony sandy loam, light phase.—The light phase of the Victor stony sandy loam is a stony sand or sandy loam extending to a depth of 10 to 14 inches. A substratum of partially weathered cobbles and large, rounded bowlders of granite and gneiss, resembling that underlying the typical Victor stony sandy loam, immediately underlies the surface soil to a depth of 6 feet or more. The grains of sand forming the surface soil of this type are angular, grading from very coarse to medium. Stones and bowlders, frequently of large size and generally rounded, are numerous. The organic-matter content of the soil is low.

Only two small areas of this phase were mapped. The larger of these lies at the mouth of the Fred Burr Canyon and the smaller at the mouth of Sweathouse Canyon.

These areas occupy the higher parts of the fans giving rise to the typical soil. They are the result of the deposition of the coarser material and of the carrying away in suspension of the fine sand, silt, and clay. Surface drainage and subdrainage are excessive. Irrigation generally is not easily accomplished on account of the stone content and porosity of the soil.

At present this phase is not used for agriculture. A virgin growth of pines still occupies a part of it. The value is low.

Average results of mechanical analyses of fine-earth samples of the typical soil are given below:

Mechanical analyses of Victor stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470341, 470318, 470359	Soil	9.6	17.3	9.8	17.4	12.3	25.4	7.9

VICTOR STONY LOAM.

The surface soil of the Victor stony loam is a medium to dark grayish brown, moderately heavy, gritty, stony loam, from 12 to 24 inches in depth. Underlying it and extending to a depth of 4 to 6 feet or more is the gritty, light-brown or yellowish to light reddish brown, loamy subsoil, which carries a large quantity of bowlders and gravel. On approaching the foot of the slopes the surface soil

becomes deeper and slightly heavier in texture. In cuts stratification of the material is visible. Stones are scattered over the surface, hindering cultivation to some extent. These become more numerous and larger toward the top of the slopes. The soil has a fair content of organic matter.

In origin, topography, drainage, and irrigation the Victor stony loam is similar to the other types of the series. The only areas mapped occur on the slopes of the alluvial fans formed by Blodgett and Big Creeks. The area in the Blodgett Creek fan lies just west of Hamilton. This area, which is somewhat elongated, borders on the east either the Bitterroot River or the low river terraces along its entire extent. It occurs on a high bank from 25 to 50 feet above the water level. The area of the Big Creek fan extends from near the canyon mouth to the river, all of it lying south of Big Creek. Some of this part of the type is of relatively low stone content. The drainage is poor, the area being subjected to seepage from the underground waters of Big Creek. The water table is high, but no alkali was observed. Wash material from the Garrison soils, which border this area, has slightly influenced it.

Much of the Victor stony loam, owing to its favorable topographic position, is better suited to orcharding than the other members of the Victor series. Near the river apples, crab apples, and truck crops are grown. That part lying toward the canyons and the area on the Big Creek fan are devoted almost entirely to pasture. The orchards yield fairly well. Dairying could well be extended. The type is all under irrigation, water being plentiful.

The Victor stony loam is a much better agricultural type than the other members of the series. Its location near Hamilton and its possible development in orchards give it a value ranging from $100 to $250 an acre for raw land. The price of land in orchards depends upon the condition and age of the trees and does not differ greatly from the prices asked for other soils similarly improved.

Results of a mechanical analysis of a fine-earth sample of the soil are given below:

Mechanical analysis of Victor stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*
470338.....	Soil.....	7.4	13.4	6.7	10.2	9.0	38.8	14.4

GARRISON SERIES.

The Garrison series includes soils of a dark grayish brown to dark brownish gray color, with light-brown to yellowish-brown or light

reddish brown subsoils. The surface soils are usually of heavier texture and less porous structure than the subsoils. The soil material is derived mainly from sedimentary and metamorphosed sedimentary rocks, occurring as accumulations of surface wash or as alluvial-fan deposits. Flat fragments of quartzite and schist occur in the soil and subsoil. In the Bitterroot Valley area these fragments as well as the finer soil material are derived mainly from the Lolo series of rocks, occurring at the lower end of the valley. These rocks consist of moderately metamorphosed quartzites, limestones, and banded slates, some of them of purple color.[1] Granite and gneiss also occur to a small extent in the parent material. The surface is of moderate to rather steep slope and drainage is good to excessive.

The topography is moderately sloping to steep and hilly. The surface in general is not very smooth, and in places it is broken by rock outcrops. Distinct remnants of high terrace lines are noticeable. Perennial streams flowing in deep valleys traverse the areas.

The series is represented in this area by one type, the gravelly sandy loam, with a stony phase.

GARRISON GRAVELLY SANDY LOAM.

The Garrison gravelly sandy loam is a dark brownish gray to dark grayish brown gravelly sandy loam, 12 to 20 inches deep, underlain by a light yellowish brown or pale-yellow gravelly sandy loam or loam carrying a relatively large proportion of silt and extending to a depth of 3 to 6 feet or more. The surface soil is sometimes quite silty or heavy in texture and may approach a loam. A considerable content of organic matter is indicated by the dark color of the surface soil. Medium to large quantities of platy gravel are present in the soil, and the subsoil and underlying substratum carry rounded and subangular gravel and bowlders. At a distance from the adjacent steeper mountain slopes deep cuts show stratification of the material. The type is generally uniform, except in depth. This is much less at the upper margin next to the foothills or mountainsides, increasing with descent toward the valley.

The Garrison gravelly sandy loam is developed on both sides of the valley, at the lower end of the area. The chief areas lie west of the river, west of McClain. An area of considerable size also occurs north of Eightmile Creek, east of the river. The areas form narrow terraces and slopes, often steep. Cultivation and irrigation are in many places difficult, and erosion not uncommonly results from irrigation. Drainage is good and in some areas excessive. Drainage ways, some of good size, dissect the type.

The Garrison gravelly sandy loam extends from the foothills or from the higher lying stony phase of the same type in a uniform

[1] U. S. Geol. Surv. Prof. Paper 27, p. 16.

slope to the lower lying river terraces, or covers rock terraces with a mantle of soil of varying depth. Small outcrops of the rocks forming these terraces occur.

The type, because of its small extent, is not of great importance in the valley. The native growth consisted of pines. On the West Side some apple and sweet-cherry orchards have been set out. The remainder of the type is used for the production of grain and as pasture. Orchards are irrigated and given the same clean culture as on the other soils of the valley. The type lies well above the valley floor and is comparatively free from injurious early frosts. Orchards are not in bearing yet, but a few old trees, planted around the houses, have borne fair yields of fruit of good size and quality.

Wheat grown on the terraces west of the river is irrigated; east of the river it is dry farmed, with alternate years in fallow. Care is necessary in irrigating this type, as it is subject to erosion and gullying.

The value of the type varies greatly. The price of orchard land on the gentle slopes of the West Side is $400 to $500 an acre, and of the land used for growing wheat or for pasture from $50 to $150 an acre.

Garrison gravelly sandy loam, stony phase.—The stony phase of the Garrison gravelly sandy loam is indicated upon the soil map by stone symbols in the color used for the typical soil. The surface soil is a sandy loam of medium to dark brownish gray color, varying in depth from a few inches to 30 inches and carrying considerable grit and angular rock fragments. The subsoil is a yellowish or light reddish brown, gravelly sandy loam or loam ranging in depth from several inches to 6 feet or more. Near the mountain slopes the surface soil is shallow and is immediately underlain by bedrock. Bowlders, angular to rounded in shape, and consisting predominantly of quartz and quartzite, but also of limestone and schist, occur in the surface soil and subsoil. Rock outcrops are occasionally seen. Usually the soil contains a fair percentage of organic matter.

The stony phase of the Garrison gravelly sandy loam is inextensive, occurring as several small areas on the foothills on both sides of the river at the lower end of the area. Its surface is generally steeply sloping to hilly and broken by terraces and occasional rock outcrops. Drainage is excessive throughout.

The soil is unimportant. A part of it is used in the production of dry-farmed grains, a fair crop being obtained every other year. Some orchards have also been set out. Plowing is in places difficult, owing to the presence of stones and ledges of the bedrock and steepness of the slope. Where unsuited to cultivation the land is used for grazing. The price of this land ranges from $25 to $50 an acre.

Results of mechanical analyses of samples of the typical surface soil and of fine-earth samples of the stony phase are given in the following table:

Mechanical analyses of Garrison gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Typical: 470324	Soil	10.6	11.2	6.2	12.0	12.5	36.9	10.4
Stony phase: 470352	Soil	7.4	15.6	9.0	14.0	8.0	33.4	12.5

CHAMOKANE SERIES.

As typically developed in previous surveys, the soils of the Chamokane series are brown to light brown in color, with brown to yellowish-brown subsoils overlying a substratum of sand and gravel. As occurring in the present survey the finer soil material is medium grayish brown to light grayish brown, while the coarser, sandy material of the gravelly types is of a lighter gray color. The subsoils are light gray to light brownish gray or light grayish brown and are somewhat calcareous. Often the difference in color between soil and subsoil is very slight, the latter being somewhat lighter, especially in the gravelly types. The soils are of open structure and leachy, and contain very little organic matter. Considerable mica is usually present. A gravelly substratum underlies the subsoil.

The soils are alluvial, being formed of materials derived chiefly from granites and quartzite, but in part from schist, fragments of which occur in the gravel. The surface is generally level, but is cut in places by sloughs or branching distributaries. Drainage in places is deficient, and some of the lower lying bodies are subject to seepage from higher lying, adjacent soils during the irrigating season. Much of the series is subject to inundation during floods. In many places a high water table occurs. The timber growth consists largely of cottonwood and willows.

In this area the Chamokane series is represented by two types—the gravelly sandy loam and loam. As mapped in this survey the soils include some areas of the Waterloo, Grantsdale, and Corvallis series.

CHAMOKANE GRAVELLY SANDY LOAM.

The Chamokane gravelly sandy loam is a light to medium grayish brown sandy loam, with a maximum depth of 15 inches, carrying an excess of gravel. This is underlain to a depth of more than 6 feet by a gravelly or gravelly sand stratum of light-gray to light grayish brown color, the gravel being well rounded and of medium size and

consisting largely of granite and gneiss, with some quartzite and schist. The surface soil is variable, being a fine sand in some places and in others approaching the coarse texture of Riverwash. In these variations the texture is frequently uniform to a depth of 6 feet or more.

The Chamokane gravelly sandy loam generally occupies the flood plains of the Bitterroot River and sloughs where periodical or occasional overflows occur. It is frequently poorly drained and much dissected by streams and drainage ways. The surface is often hummocky.

This type supports a growth of willow and cottonwood trees and grasses. It is the lowest lying and coldest soil in the valley, and has little agricultural value except for pasture and the production of wild hay. On the better drained areas some alfalfa and grain is grown, but the yields of grain are low and those of alfalfa moderate. Irrigation water for these crops is taken from the river a short distance above the cultivated areas.

The price of the better areas of this type ranges from $40 to $50 an acre. Areas containing an excess of gravel are practically worthless.

In the following table the results of mechanical analyses of samples of soil and subsoil of this type are given:

Mechanical analyses of Chamokane gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470348	Soil	4.0	16.2	15.2	14.4	14.4	30.4	5.5
470349	Subsoil	10.8	39.9	29.1	9.8	4.1	4.7	1.8

CHAMOKANE LOAM.

The Chamokane loam, to a depth of 12 to 20 inches, consists of a medium grayish brown, light-textured loam containing considerable silt and mica. The subsoil is a lighter grayish brown, silty, fine sandy loam or loam, extending to a depth of 3 to 6 feet or more. A deep gravelly stratum underlies the subsoil. Gravel may be scattered through the soil material, and outcrops of the gravelly substratum are also found in places. In places some areas of fine sandy loam may be included. The content of organic matter varies from moderate to high, areas carrying a large percentage being conspicuous on account of their darker color.

The Chamokane loam lies in the trough of the valley, the largest bodies occurring west of the river in the vicinity of Carlton, Florence, and Stevensville. It is alluvial in origin and covers lower terraces

and bottoms of the Bitterroot River that are seldom overflowed. The darker variations of the type have an origin similar to the Colville soils, having been deposited from slowly moving or stagnant water.

The surface of the Chamokane loam, where it has not been leveled in cultivation, is somewhat irregular. Drainage is so variable that it is impracticable to separate the well-drained from the poorly drained areas. The streams are sluggish, and semiswampy areas of some extent are numerous.

The Chamokane loam is usually covered with a moderately heavy growth of grass, which affords good grazing. Willow and cottonwood flourish along the streams and in the more poorly drained areas, while conifers occupy the better drained, uncultivated areas.

Grain and hay are grown to some extent under irrigation. Wheat yields 25 to 35 bushels and oats 40 to 50 bushels per acre. Excellent yields of hay are obtained. The type is well suited to dairying. It is not an orchard soil.

The price of the Chamokane loam ranges from $15 to $75 an acre.

Results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Chamokane loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703141	Soil	0.7	1.0	4.3	8.0	25.1	46.3	14.5
4703142	Subsoil	.0	.3	1.1	17.5	29.8	40.3	10.7

GRANTSDALE SERIES.

The soils of the Grantsdale series are of a medium grayish to dark grayish brown color, sometimes nearly black when moist. The subsoils are light gray or gray to grayish brown and, as a rule, calcareous and heavier than the surface soils. The series is underlain by a stratified gravelly stratum; in the heavier soils usually below 6 feet, but in the lighter soils nearer the surface, the subsoil in places being absent.

The series is developed from recent alluvial deposits derived from many different rocks, mainly from granite, gneiss, and quartzite. It occupies stream terraces of low to moderate elevation, and level, smooth surface, and usually lies above the normal overflow of the streams (Pl. LXXII). Drainage is good over most of the series, though some poorly drained areas and areas with a high water table occur. This condition is due in part to irrigation of higher lying soils and in part to seepage from springs or from minor streams.

The series is widely distributed in this area, occupying a large part of the valley floor. Three types are mapped—the fine sandy loam, loam, and silt loam.

GRANTSDALE FINE SANDY LOAM.

The Grantsdale fine sandy loam, to a depth of 24 to 30 inches, is a medium-brown to grayish-brown, friable fine sandy loam or light fine sandy loam, underlain by a somewhat lighter colored, silty fine sandy loam, extending to a depth of 6 feet or more. The soil contains considerable micaceous material and a moderate percentage of organic matter and retains moisture fairly well. The area of this type along Willow Creek is gritty, has many stones scattered over the surface, and is underlain at 4 feet or less by a gravelly, sandy substratum.

The Grantsdale fine sandy loam is not of great extent. The largest and most important area lies along Willow Creek. A long, narrow area occurs west of Corvallis. Another area occurs in the vicinity of the Alford School.

The surface is smooth and the type is readily cultivated and irrigated. The area on Willow Creek is well drained, but in other places drainage is poor, owing to the high water table, which in some places lies within 3 feet of the surface.

Owing to its small extent, this type is unimportant agriculturally. Some apple orchards have been set out along Willow Creek, the remainder of the type being used for general farming and pastures. Clean culture and irrigation are practiced in the orchards, and while the trees are not yet in bearing they have a healthy appearance and have made a fair growth.

Potatoes are grown to a small extent on the valley floor, only fair yields being obtained owing to the high water table in that part of the type. Some truck crops are grown for home use and appear to do well.

The price of land used for general farming ranges from $50 to $100 an acre, while land in orchards brings about the same price as on other types.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Grantsdale fine sandy loam:

Mechanical analyses of Grantsdale fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470380	Soil	1.8	11.4	13.4	26.6	14.9	24.3	7.7
470381	Subsoil	.6	4.4	8.0	30.2	20.1	29.8	6.8

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470380, 0.95 per cent; No. 470381, 0.52 per cent.

GRANTSDALE LOAM.

The Grantsdale loam is a medium grayish brown to dark grayish brown friable loam of rather light texture and from 12 to 14 inches deep. The subsoil usually consists of a lighter grayish brown loam, extending to a depth of a little more than 3 feet. Underlying this is the typical gravelly and sandy stratum of the series. There is some variation in the texture of the soil. As the silt loam of the series is approached the color becomes lighter and the texture more silty, and as one nears the benches and gravelly types the texture becomes somewhat coarser. In the latter situations also some rounded cobbles are scattered over the surface. The presence of mica flakes was noted. The content of organic matter is moderate.

The Grantsdale loam is developed only east of the river. The principal areas lie at the base of the high terraces east of Stevensville and Victor, occupying a part of the old river channel. Other areas of importance occur in the vicinity of Hamilton and a smaller area east of Bass Station.

The topography is uniform and smooth and favorable to irrigation. Drainage is usually deficient, as the result of a high water table. Seepage from the higher lands largely has caused this condition, the type occupying a somewhat lower position than other soils nearer the river. Alkali has accumulated in spots, but not to so large an extent as in the silt loam.

Surface wash from the old benches of the east side has been deposited upon this type to a greater extent than upon any other type of the series, with the exception of the silt loam. This has been brought down and deposited by minor intermittent drainage ways.

This is a good general-farming soil and all of it is in use. Upon areas where there is no alkali potatoes do well, and this crop is grown upon a commercial scale, most extensively in the vicinity of Hamilton. The yields ordinarily range from 150 to 350 bushels per acre. Irrigation is necessary. The potatoes are of good size and quality. The bulk of the crop is shipped to other parts of the State and to the East.

Grain is grown mainly in the section east of Victor. With irrigation very good yields of wheat are obtained, ranging from 35 to 50 bushels per acre, but the grain is soft and inferior for milling. Oats are better suited to the soil and climatic conditions and are largely grown in the same localities in which wheat is grown. Yields are large, 60 to 75 bushels per acre being frequently obtained. The grain is heavy and otherwise of fine quality.

Stock raising and dairying are carried on to a small extent.

Some barnyard manure is applied to this soil, but little or no commercial fertilizer is used.

The price of land of the Grantsdale loam varies greatly, being highest in the vicinity of towns. On the outskirts of Hamilton land of this type has been sold for $400 an acre, while land suitable for general farming, but more remote from the towns, is worth from $75 to $150 an acre. Where the type contains alkali spots its value is slightly reduced. Owing to the small size of these spots, however, they do not greatly affect the yields.

Owing to its high water table, the Grantsdale loam requires artificial drainage before deep-rooted crops can be successfully produced. The slope of the valley is such that drainage is feasible.

Average results of mechanical analyses of samples of the soil and subsoil follow:

Mechanical analyses of Grantsdale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470388, 470390....	Soil.....	3.6	6.4	4.9	14.9	21.6	40.2	8.1
470389, 470391....	Subsoil.....	1.9	4.5	4.2	17.8	22.5	39.4	9.3

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470389, 4.72 per cent; No. 470390, 2.36 per cent; No. 470391, 6.75 per cent.

GRANTSDALE SILT LOAM.

The Grantsdale silt loam is the lightest colored soil in the Grantsdale series. The surface soil is a heavy, sticky, silty loam of light to medium grayish brown or light brownish gray to lighter yellowish brown color and from 12 to 16 inches deep. The subsoil is a silty clay loam of lighter gray to lighter brown color. The gravelly, sandy stratum which underlies the Grantsdale series is encountered at a depth of 4 to 6 feet or more. Both soil and subsoil are compact and hold moisture well. The type is not high in organic matter. It contains relatively little mica. While alkali is more abundant in this type than in the other soils of the series, it affects the land only slightly and does not interfere seriously with crop production. The most affected areas are encountered on Willow Creek and on the valley floor east of Victor. A few loose stones or rocks are scattered over the surface of this type, especially where it comes in contact with a stony or gravelly type.

The Grantsdale silt loam occupies a part of the main valley floor east of the river, between Weeping Child Creek and Burnt Fork Creek. It occurs as long, narrow areas lying under or close to the high terraces, and generally is separated from the river by the more gravelly types of the series. Like the Grantsdale loam and the types of the Corvallis series, it occupies a slight depression and is somewhat lower than the types between it and the river.

The topography is level and smooth. The water table is near the surface and drainage is poor. The type is dissected by only a few drainage ways, and these are very shallow.

The Grantsdale silt loam is the principal grain and general-farming soil of the valley floor. Wheat and oats, the main crops, are grown under irrigation. Spring wheat is largely grown. Yields of 40 to 50 bushels of wheat per acre are not uncommon, and as much as 100 bushels of oats per acre has been obtained. The average yields are probably about a third less. The soil is not so well adapted to wheat as to oats. Hard varieties of wheat grown under the moist conditions prevailing usually become soft. Oats grown upon this soil are heavy and of excellent quality.

Hay and potatoes are also produced to a small extent. Only grasses suited to a wet soil can be successfully grown for hay, but of these fair yields are obtained. Most of the hay is produced in the section just east of Hamilton. Only a small part of the type is used for pasture. Some field peas are grown for seed upon the better drained portions of the type and do fairly well. The soil is not well suited to orcharding and has not been used for this purpose on a commercial scale.

Little or no commercial fertilizer and only small quantities of barnyard manure are used on grain or other crops. The price of the land ranges from $50 to $200 an acre.

Artificial drainage is required to lower the water table, which is too high for the production of deep-rooted crops.

In the following table the average results of mechanical analyses of samples of the soil and subsoil of the Grantsdale silt loam are given:

Mechanical analyses of Grantsdale silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470384, 470386....	Soil.....	0.9	1.9	2.2	6.0	8.8	64.9	14.5
470385, 470387....	Subsoil.....	.5	2.0	2.2	6.3	9.3	58.9	20.4

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470385, 8.34 per cent; No. 470386, 7.84 per cent; No. 470387, 20.31 per cent.

Waterloo Series.

The soils of the Waterloo series are medium grayish brown to dark grayish brown and are underlain by porous, gravelly subsoils, usually of a lighter brown color, resting upon a stratum of porous sands and gravels. As recognized in previous surveys, the material of this series is derived from old lake or river deposits now occupying the position of terraces and of glacial outwash origin, with a substratum

of stratified sand and gravel. In the present survey the glacial character of the material is, at least to a great extent, questionable. The subsoils are also frequently grayer and sometimes calcareous. The surface is gently sloping and is in places dissected by streams. Drainage is usually well developed and both soil and subsoil are leachy. The series is represented in this survey by three soil types—the sandy loam, gravelly sandy loam, and stony sandy loam, the two last named being indicated in sandy loam color by symbols.

WATERLOO SANDY LOAM.

The Waterloo sandy loam consists of 12 to 24 inches of medium grayish brown light sandy loam, sometimes approaching a sand, underlain by a lighter gray to light grayish brown, porous, gravelly sandy loam or sand, which usually extends to a depth of more than 6 feet. Some rounded stones or cobbles are scattered over the surface and through the subsoil. In places in the vicinity of Threemile School the soil is heavier than typical. The gravel substratum characteristic of the Waterloo series underlies the subsoil at a greater depth than in most of the types of the series. This type also contains more mica than is usual in types of this series.

The principal areas of the Waterloo sandy loam occur in Threemile Valley. Smaller, unimportant areas are mapped southeast of Conner School, near Darby, in the Weeping Child Valley, on Skalkaho Creek, and east of Corvallis and Victor. The surface of the larger areas is gently sloping. The smaller areas form small alluvial fans, derived mainly from old valley-filling material. The drainage of the type as a whole is excessive. Shallow stream channels drain most of it.

The Waterloo sandy loam is an important orcharding soil, the greater part of the larger areas having been set out in apple, sweet-cherry, and crab-apple trees. The smaller areas are little used except for pastures, and these are poor, as heavy rains are likely to cover the fans with fresh deposits of soil.

The varieties of fruit common to the valley are grown on this type. McIntosh is the leading variety of apple. The fruit matures late and colors well. As the orchards are not yet in full bearing, there are no data on yields. The trees as a rule are fairly thrifty, but those planted on the lighter textured portions have not made a normal growth. In the lower part of the valley, where the soil is heavier, the trees make a good growth, but the growing season is shorter.

Little has been done to improve this soil. It is low in organic matter and leachy, and is greatly benefited by liberal applications of barnyard manure and the growing and plowing under of winter cover crops. But little commercial fertilizer is used.

The price of orchard land of this type, with trees 5 years of age, is $500 an acre. Land suitable for orchards, but on which no trees have been set out, has been sold for $200 to $350 an acre, with water rights. There is very little of such land available. Land on the smaller areas of this type, where there are no orchards, usually takes its value from adjoining types.

Average results of mechanical analyses of samples of the soil and subsoil of the Waterloo sandy loam are given in the following table:

Mechanical analyses of Waterloo sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470366, 4703112	Soil	9.9	9.9	6.9	29.9	17.8	21.0	4.5
470367, 4703113	Subsoil	16.1	18.1	13.0	21.8	13.6	13.4	3.8

WATERLOO GRAVELLY SANDY LOAM.

The Waterloo gravelly sandy loam is indicated on the soil map by gravel symbols in Waterloo sandy loam color. It consists of a medium grayish brown, gritty, heavy to light, gravelly sandy loam, from a few inches to 12 inches in depth, underlain by a deep, porous, gravel and sand stratum of light-gray or grayish-brown to brown color. The type is low in organic matter and irretentive of moisture. It is somewhat calcareous. The quantity of gravel is variable, and the size ranges from small to medium. The type varies considerably in depth. In narrow strips and spots the gravel substratum closely approaches the surface; in other places where the type borders the higher lying terraces the surface soil is much deeper, of a darker color, and heavier in texture than is typical.

The Waterloo gravelly sandy loam is a valley-floor soil, occupying terraces lying well above the flood plain of the Bitterroot River. It occurs as narrow strips lying along or close to the river on both banks from the southern extremity of the area to Threemile Creek on the north.

The surface is generally smooth and cultivation comparatively easy, but irrigation is difficult owing to the rapidity with which water passes through the soil. In places where large irrigation canals traverse the type the water table is high during the irrigating season.

Uncultivated areas still support the original forest growth of pine. The type affords but little pasturage without irrigation. Some apple orchards have been set out. General farming is carried on in places, especially where the depth to the gravel substratum is comparatively great. Alfalfa does fairly well, but requires an abundance of water. Grain does not do so well as alfalfa.

The value of land of this type varies according to quantity of gravel in the surface soil, the depth to the gravel substratum, and the location. Farm land in the vicinity of Hamilton ranges in price from about $25 to $150 an acre.

Mechanical analyses of samples of the soil and subsoil of the Waterloo gravelly sandy loam follow:

Mechanical analyses of Waterloo gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470392, 470394, 470304.	Soil.....	7.2	14.3	9.1	14.5	13.0	32.1	9.3
470305.....	Subsoil.....	23.4	21.0	12.6	20.1	9.3	8.0	5.5

WATERLOO STONY SANDY LOAM.

The Waterloo stony sandy loam is indicated upon the soil map by stone symbols in the color of the Waterloo sandy loam. The surface soil of this type is a medium grayish brown to dark brownish gray, moderately heavy, gritty sandy loam, from 6 to 14 inches deep, carrying quantities of large well-rounded, quartzite cobbles and bowlders. The subsoil is generally a gravelly sandy or coarse sandy loam of a somewhat lighter color, and also carries an excess of rounded bowlders. Underlying the subsoil at a depth of 3 to 6 feet is a gravelly sandy stratum. In depth the soil varies considerably. This type differs from the Waterloo sandy loam chiefly in the quantity of stones lying upon the surface. It also is usually shallower. The stones occurring on the type are derived from granites and rocks of the metamorphosed sedimentary formations.

The Waterloo stony sandy loam is a friable, rather porous soil, only moderately retentive of moisture. The content of organic matter is moderate to small.

The largest areas of this type occur in the vicinity of Threemile Valley and in the vicinity of Stevensville, where the type is one of the chief soils of the Burnt Fork Valley. Other smaller areas occur as strips lying between the eroded types of the Burnt Fork series and the soils of the valley floor. It occupies the low terraces elevated well above the normal overflow of Burnt Fork and is well drained. The surface is slightly undulating and rather smooth, except for the stones scattered over it. It is dissected by a few shallow, intermittent streams.

The Waterloo stony sandy loam is not as important to the agriculture of the area as some of the other types of the series. The larger part of the type is used for grazing, to which it is best suited. This

is the use made of it where it forms a part of the farms embracing other types. With liberal irrigation it affords good pasturage. While all of it is capable of irrigation, a part of it lying well up in the valley of Burnt Fork is not cultivated, owing to the large number of stones which it contains. In the Threemile Valley orchards have been set out. Grain is grown on that part of the type lying out in the main valley. Wheat yields from 25 to 35 bushels per acre.

The price of land ranges from $25 an acre where very stony to $100 or more where it can be used for grain and other crops. Orchard land has about the same value as on other types.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Waterloo stony sandy loam:

Mechanical analyses of Waterloo stony sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470382	Soil	7.2	13.9	9.2	14.6	12.0	33.3	9.8
470383	Subsoil	15.7	17.5	8.4	12.0	16.0	23.7	6.8

Corvallis Series.

The soils of the Corvallis series are dark gray to dark brownish gray or black in color. The upper subsoils are much like the soils, the lower subsoils are gray to light gray and overlie a gravelly stratum at depths of 2½ to 5 feet. The subsoils are calcareous, effervescing in acid. The soils are high in content of organic matter, compact, and retentive of moisture. They are alluvial in origin, the materials being derived mainly from granite, quartzite, and schist, with some admixture from slate, shale, and associated sedimentary rocks. The topography is that of a level flood plain, dissected by sloughs and drainage ways, and the drainage is relatively poor, owing to a high water table. The Corvallis series differs from the Grantsdale, Waterloo, and Chamokane series chiefly in drainage and in the color and nature of the soil and subsoil. Three types are mapped in this area—the Corvallis loam, stony loam, and silt loam.

Corvallis loam.

The Corvallis loam consists of a dark-gray to dark brownish gray, compact silt loam from 12 to 24 inches deep, underlain by a lighter gray to a slaty or drab-colored loam or clay loam. In places the surface soil may contain some grit, especially where it lies close to the gravelly types or where sand has been washed down upon it, but

this is exceptional. The depth of soil varies greatly within small areas, especially in the smaller stream valleys, increasing as the main valley is approached. The subsoil may carry considerable grit or may be smooth and silty. Its depth varies also. While it may give way to the gravel substratum at a depth of less than 3 feet, it may extend to 6 feet. Usually the depth is much less than 6 feet. In the Threemile Valley the subsoil often has a reddish-brown tinge. Here it carries more gravel and some larger stones. The type carries considerable organic matter and varying quantities of mica. Rounded gravel and stones of mixed origin are scattered over the surface in places, being most numerous where the silt loam comes in contact with the gravelly or stony types.

The Corvallis loam was encountered on both sides of the valley throughout its extent. It is a soil of the overflow plain of the Bitterroot River and its tributaries, and much of it is subjected to overflow. The principal areas lie east of Victor. Though the surface of the type is generally smooth, it is much dissected by drainage ways and sluggish sloughs, often of good size. It is poorly drained and has a high water table.

The Corvallis loam is one of the more extensive soils of the valley. Cottonwood and willow grow along the sloughs. The greater part of the type is used for pasturing horses, cattle, and hogs. The cattle consist mostly of beef breeds, although some dairy animals are kept. Good yields of grain are frequently obtained on areas little subject to overflow. Oats yield from 40 to 50 bushels per acre. Wheat does not do so well as oats.

Garden vegetables, including potatoes, are grown on this soil where it is adequately drained. On the moister areas timothy and other hay crops do well. The crops grown are in part irrigated, water being easily available. None of the type is suited to fruit growing.

The price of land of this type is generally not high. The better drained areas are held at about $75 an acre, and the lower lying areas are of much lower value.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Corvallis loam:

Mechanical analyses of Corvallis loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470368, 4703127	Soil	4.7	7.3	4.7	8.2	12.9	47.7	14.3
470369, 4703128	Subsoil	3.7	7.1	7.1	15.9	12.3	42.7	10.6

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$): No. 470369, 2.40 per cent; No. 4703127, 1.75 per cent.

CORVALLIS STONY LOAM.

The Corvallis stony loam, which is shown upon the soil map by stone symbols in Corvallis loam color, differs from the loam chiefly in the larger proportion of stones it contains.

The surface soil is similar in color to the loam, being dark gray to dark brownish gray, and the subsoil is dark gray or slaty gray. Both soil and subsoil carry an excess of rounded bowlders, generally of quartzite and granite. The soil is usually of a smooth, silty texture, but it may contain some grit, derived from adjoining types. Both soil and subsoil are shallower than in the loam, and in places the gravelly substratum comes close to the surface. Generally the surface soil is but 6 to 10 inches deep, and the subsoil is underlain at a depth of 16 to 20 inches by a stratified gravelly and sandy layer. A considerable quantity of mica is present in many areas. The soil and subsoil also carry much organic matter.

The type is of very small extent. The chief areas occur near Corvallis and in the Burnt Fork Valley. The surface is not as smooth as that of the typical Corvallis loam and the soil is much more difficult to irrigate and cultivate, on account of the high stone content. Practically the entire type is used for pasture.

The land is always sold in conjunction with other types.

CORVALLIS SILT LOAM.

The Corvallis silt loam is a dark-gray to dark brownish gray sticky silt loam, from 6 to 18 inches in depth, underlain by a mottled gray silt loam to silty clay loam, extending to a depth of 3 to 6 feet or more. Gravel and stones are frequently seen upon the surface and also in the subsoil. Underlying the subsoil and extending to a great depth is the gravelly sandy substratum characteristic of this series. Both soil and subsoil are somewhat micaceous. The type has a high content of organic matter. It is locally referred to as "leaf mold." Small alkali spots are encountered in places.

The Corvallis silt loam is confined entirely to the East Side. The chief areas lie out on the valley floor in the vicinity of Corvallis, while a smaller one occurs just north of Como, and a long, narrow body occurs northeast of Stevensville. The type is inextensive and unimportant.

The surface is usually level, or consists of shallow depressions in the valley floor.

Drainage is poor, and the ground water is very close to the surface during the irrigating season. A few shallow drainage ways traverse the type.

The greater part of the type is used for pasturage. Some hay is also produced. In the better drained situations grain and garden

vegetables are grown and good yields obtained. No fertilizer is used.

The price of this land is generally dependent upon that of better soils with which the type usually is associated, and ranges from $50 to $100 an acre.

Average results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Corvallis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4703123, 4703125...	Soil.....	1.3	2.3	3.1	8.8	14.0	55.2	15.4
4703124, 4703126...	Subsoil.....	.3	1.7	2.1	9.3	19.4	56.3	10.8

The following samples contained more than one-half of 1 per cent calcium carbonate ($CaCO_3$) : No. 4703123, 30.52 per cent; No. 4703125, 1.47 per cent.

Colville Series.

The soils of the Colville series are black and the subsoils dark gray, mottled gray or slaty gray. The series is underlain by a stratified, gravelly, sandy stratum. The gravel consists chiefly of granite and gneiss, with some quartzite and schist. While the underlying gravel layer is open and porous, the silty subsoil is very compact and retains moisture well. The soils and subsoils have a high organic-matter content, which gives the material the dark color. The series is alluvial. Drainage is poor and the water table lies close to the surface.

The Colville series in this survey is inextensive and unimportant. It does not differ greatly from the Corvallis series, except in its darker color. Only one type was mapped, the Colville silt loam.

Colville silt loam.

The Colville silt loam consists of 20 to 30 inches of smooth-textured silt loam, underlain by a dark-gray or slate-colored silt loam or silty clay loam, which extends to a depth of 3 to 6 feet or more. Underlying the subsoil is a gravelly, sandy substratum of unknown thickness. The soil is somewhat micaceous and contains an unusually large percentage of organic matter. It is of peaty or boggy character, but supports the weight of grazing animals very well. The type varies slightly where it borders the gravelly types, containing some gravel and being shallower than usual.

Only one area of the Colville silt loam was encountered in the survey. This occurs as a long strip north of Charlos, on the West Side. It occupies a slight depression having a uniformly level surface. Drainage is poor and the water table high. The type is sub-

ject to overflow from the several drainage ways which traverse it, and to seepage from the higher lands. It occupies a position well above the river.

Water-loving grasses and other vegetation flourish on this soil. Its chief use is for pasture and the production of hay. Fair yields of timothy and mixed hay are obtained. The land has nearly all been in pasture and hay for a number of years, and is not cultivated to any extent. In the better drained locations a little grain is grown, but it does poorly. No fertilizer is used on the soil. The price of the land ranges from about $50 to $75 an acre.

Artificial drainage is necessary before general farm and truck crops can be successfully grown on this type. Drainage can be easily established. The type would not be suited to orcharding even if drained.

Lolo Series.

The Lolo series includes types having dark-gray to dark brownish gray or black soils and light grayish brown or brown subsoils, generally gravelly, and underlain by porous sands and gravels. The series is derived from recent alluvial deposits, formed chiefly of quartzite materials, with some from cherty slate and limestones. The soils occupy low terraces or bottoms, but are usually above overflow. Drainage is usually good. Most of the areas have a smooth, gently sloping surface. The soils of this series are distinguished from those of the Grantsdale series by their prevailingly darker color and by the absence of the light-colored, calcareous subsoils. The series is represented in this area by one type, the gravelly loam.

Lolo gravelly loam.

The surface soil of the Lolo gravelly loam consists of a dark brownish gray or dark-gray gravelly loam containing a medium to large percentage of organic matter and a considerable proportion of silt. It varies in depth from 6 to 8 inches in the upper part of Eightmile Valley to 20 to 24 inches in other places. The subsoil is usually a light grayish brown or light-brown, porous, gravelly sandy loam more than 6 feet in depth. East of the main Lolo Road, where this type approaches the river, the soil and subsoil overlie a gravel substratum very similar to that found beneath the Chamokane soils. Large quantities of subangular to flat waterworn gravel are distributed throughout the soil material. The surface soil has been changed somewhat where wash from the Curlew terraces, which border the type for 2 miles west of Lolo, and from residual, steep slopes beyond this, has been deposited, but otherwise shows little variation. At the junction of the Lolo and Bitterroot bottoms some fine sand has been added by flood water from the latter stream.

The Lolo gravelly loam lies on both sides of the valley at the lower end of the area, occupying the recent flood plain of Lolo and Eightmile Creeks. It forms a low, gently sloping river terrace, lying 10 to 20 feet higher than the terrace along the Bitterroot River, where the two join.

Lolo Creek finds its way through the middle of the main area of the type by means of a number of channels flowing 10 to 20 feet below the main terrace. While drainage on the main terrace is good, most of that part of the type lying between the outermost channels of the stream is low, poorly drained, and subject to overflow. The surface of that part of the type located in the bottoms of Eightmile Creek is more uniform, no drainage ways of importance traversing it.

Considerable areas of the Lolo gravelly loam have been set out to orchards. Some of these are in bearing, but most of the trees are yet too young. The orchards consist of apple and sweet and sour cherry trees, the apple plantings predominating. A sweet-cherry orchard in the upper part of the valley of Eightmile Creek, close to the mouth of the canyon, has borne good crops for a number of years. Another large orchard, located in the Bitterroot Valley, which has been in bearing for a number of years, produces good yields of fruit of good quality.

Truck crops, including Irish potatoes, are grown on this type in the vicinity of Lolo. Potatoes yield well, and the tubers are of good size and quality.

In the Eightmile Valley grains do fairly well with irrigation, wheat yielding 30 to 35 bushels and oats 40 to 50 bushels per acre.

A part of the type is used for grazing stock, but unless the land is irrigated the pasturage is scant.

The value of the type varies greatly. Where it supports orchards it is considered as valuable as any other orchard land in the valley, but the area suitable for this purpose is relatively small. The town of Lolo is located on this type, which enhances its value in that vicinity. The price of farm land other than that in orchards ranges from about $50 to $250 an acre.

The same methods of cultivation are followed on this type as on the other soils of the area.

Average results of mechanical analyses of samples of this soil are given in the following table:

Mechanical analyses of Lolo gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
470322, 470326, 470370.	Soil.....	7.7	13.1	7.5	9.3	10.0	40.2	11.9

Miscellaneous Material.

ROUGH BROKEN LAND.

Rough broken land occupies foothill slopes and eroded portions of the higher terraces. The slope is usually steep, but there is but little of the rock outcrops characterizing Rough stony land. The areas include both residual and transported material.

Most of the Rough broken land lies east of Threemile Creek, south of Ambrose Creek, northeast of Eightmile School, and southeast of Grantsdale on the east side of the river.

The chief use of this land is for grazing, to which it is best suited. Only a small part of it is suitable for cultivation.

ROUGH STONY LAND.

Rough stony land includes mountain and foothill-slope areas, which, because of their rough and stony character, have no value except for grazing. Outcrops of the bedrock are numerous in this land. The shallow soil occurring in places is of residual origin.

The Rough stony land is well watered and affords an extensive grazing area for all kinds of stock during the greater part of the year.

ALKALI.

But little trouble is experienced from the occurrence of alkali salts in the soils of the area. No extensive areas occur in which the soil is badly affected by alkali, but in a slight depression near the base of the high terraces on the East Side and in narrow areas paralleling the larger eastern tributary of the river there are spots, usually only a few feet in diameter, where the concentration of alkali salts is great enough to retard or prevent plant growth. Such spots are shown upon the soil map by red lines and red-letter symbols.

Indications point to the occurrence of sodium carbonate ("black alkali") in the affected spots.

DRAINAGE.

With the exception of small parts of the valley floor, the area covered by this survey is naturally well drained. The large quantity of irrigation water used has caused a high water table in the lower parts of the valley, especially along the foot of the benches on the East Side and to some extent in the center of the valley floor, and there are some poorly drained areas along the river and the sloughs of the valley trough where overflows take place. These are most extensive on the East Side. Those on the West Side lie along the river in the vicinity of Stevensville. Without artificial drainage and protection from inundation, this overflow land is of little value except for pasture.

The soils of the Chamokane, Corvallis, and Colville series are the ones most subject to overflow. Swampy areas in other soils of the valley floor have been indicated on the soil map by the usual swamp symbol. The three series referred to and parts of the Grantsdale series have a high water table.

The fall of the valley from Darby to Lolo averages 10 feet per mile, which should be sufficient for draining the wet areas, but the project would have to be comprehensive and would probably prove expensive.

IRRIGATION.

The Bitterroot Valley is very well watered. The Bitterroot River has the largest flow of any of the streams, but furnishes only a small part of the water used in irrigation, for the reason that the perennial streams of the West Side furnish a more easily obtainable supply. The grade of these streams is much steeper than that of the river, and shorter canals can be used in distributing the water. On the East Side the larger streams supply some water, but most of it is obtained from Lake Como, at the mouth of Lick Canyon, on the West Side, whence it is conducted across the river, hills, and terraces to the Eightmile Valley, opposite Florence. All the water is carried by gravity canals, the system in general use being that of "continual flow."[1] It is also possible to obtain water from the large Bitterroot Valley canal on the east side of the valley. The water from the streams and lakes is cool, clear, and wholesome throughout the year and is used for domestic purposes as well as for irrigation, wells being very scarce.

According to the census reports there were 400 irrigation projects in Ravalli County in 1909. Of the 1,055 farms in the county that year, 975, embracing 93,441 acres, or 87.6 per cent of the improved land in farms, were irrigated. That part of the area occurring in Missoula County is irrigated just as extensively and in the same manner. In 1909 there were in Ravalli County 364 main ditches, with a length of 682 miles, and a capacity of 4,235 cubic feet per second. The number has increased since that year. The Bitterroot Irrigation Co. ditch alone carries 600 cubic feet of water per second. The average total cost per acre, for which cost is reported in 1910, was $1.08. The cost of operation and maintenance under the large projects is greater than the average for the valley. In the southern part of the area it is $2 per acre.

Irrigation is necessary in the production of intensive crops in the Bitterroot Valley, especially on the soils of lighter texture. Many of these soils are easily eroded, and great care is necessary to prevent

[1] See Bul. 226, Office of Expt. Sta., U. S. Dept. Agriculture; also Bul. 118, Utah Agr. College Expt. Sta.

injury in the distribution and application of water. The handling of the water often presents difficulties which arise from the fact that the soils are porous and stony and occupy steep slopes. Owing to the porous nature of many of the soils great quantities of water are applied. This causes the ground water to rise during the growing season, but it subsides after irrigation ceases for the year. Little or no leveling is done on the comparatively level areas, the furrow system of distributing water chiefly being used.

Irrigation is practiced at relatively high elevations, frequently extending on the foothill slopes to over 4,000 feet above sea level.

SUMMARY.

The Bitterroot Valley area covers about 511 square miles, or 327,040 acres, in Ravalli and Missoula Counties, Mont. It lies along the Bitterroot River and between the mountains of the same name on the west and the foothills of the Rockies on the east. The average elevation of the valley is about 3,500 feet above sea level. Few points have an elevation of more than 4,000 feet.

The first permanent white settlement was established at Stevensville in 1850. Hamilton, with a population of 2,240, is the chief town of the area. Other smaller towns of importance are scattered throughout the area.

The public roads are good, and railroad facilities are ample. Butte and Missoula are the principal markets in the State. Many of the products are shipped to distant markets.

The mean annual temperature is 45.8° F., and the mean annual precipitation 10.71 inches. The precipitation is greater over the Bitterroot Mountains and foothills than in the foothills of the Rockies, and less in the valley proper than in the foothills. Irrigation is necessary for the successful production of crops, except grain which is dry farmed where water is not available.

Agriculture has progressed steadily since the area was first settled. The production of orchard fruits, chiefly apples and cherries, is the most important industry. Among the general farm crops are wheat, oats, potatoes, and hardy truck crops. Considerable numbers of horses, cattle, sheep, and hogs are raised, and some attention is also devoted to dairying.

The soils of the area are classified, according to mode of origin, under six main groups, viz: Soils derived from residual material; soils derived from both ice-laid and water-laid glacial material; soils derived from old valley-filling deposits; soils derived from recent alluvial-fan material; soils derived from other recent alluvium; and miscellaneous soils, mainly nonagricultural.

Exclusive of Rough broken land and Rough stony land, 36 distinct soil types are mapped. These have been grouped in 15 series.

The residual soils occur on the foothills, are usually shallow, and are not important agriculturally.

The ice-laid glacial soils have a rolling to steep topography, are rather coarse textured, and well drained. Those derived from water-laid glacial material occupy high, sloping terraces on the west side of the valley and are well drained. They are important agricultural soils.

The soils derived from the old valley-filling material form the high terraces and slopes of the East Side. Some of the types are underlain by hardpan; usually they are somewhat eroded, and the texture is generally moderately heavy. These types are often very stony. The drainage is good. These soils are both extensive and important agriculturally.

The recent alluvial-fan soils are quite extensive on the west side of the valley, but occur also east of the river. The soils are usually rather shallow and stony. The drainage is good. Both dry-farmed and irrigated crops are grown.

The soils of the recent alluvial flood plain and terraces occupy the valley floor. Drainage, while retarded in some of the types, is generally fair. Most of the types are stony or gravelly. These include valuable agricultural soils, but they are not so well adapted to orcharding as the soils of higher lying groups.

Irrigation is practiced very extensively. Both the Bitterroot River and perennial tributary streams of the West Side supply an abundance of water. The streams of the East Side are intermittent or supply only small quantities of water.

Some alkali occurs in the soils of the valley floor, generally in small spots. Alkali causes little trouble, and accumulation will probably never become extensive.

Some of the soils of the valley floor require drainage.

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